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The Journal of
Bone and Joint Surgery

EDITORIALS AND ANNOTATIONS

FIXED PARALYTIC PELVIC OBLIQUITY AND RELATED DEFORMITIES OF THE TRUNK

In 1932 Lowman presented his pioneer work on the value of free fascial grafts to strengthen weak abdominal muscles, including grafts taken from the fascia lata and run from the ribs, the iliac crest, or the symphysis pubis to the umbilicus, and in two cases from the iliac crests to the umbilicus on one side below and from there to the rib margin on the opposite side above.[1] Recently, after twenty years of further experience, Lowman confirmed the beneficial results that can be derived.[2] He did not attempt a statistical review of his results, and apparently has abandoned the method of inserting the graft to the umbilicus and instead has run it direct from bone to bone, a method first advocated by me in 1935.[3]

I first discussed fixed paralytic pelvic obliquity in 1925 in an unusual case of progressive inequality of leg length in a woman of thirty-eight years who had suffered poliomyelitis at the age of four years.[4] There was no unequal rate of growth of the bones, but there was fixed abduction contracture of the hip causing downward tilt of the pelvis. By means of a release operation, and a fascial graft to strengthen the paralysed adductors, the pelvic obliquity and inequality of leg length were corrected as confirmed by a twenty-five year follow-up. Further studies of fixed pelvic obliquity soon showed that abnormalities of the pelvi-femoral muscles represented only one group of cases, and that there was a second group with pelvic obliquity from involvement of the trunk muscles.[5] It seemed that a fascial graft could be used to greater mechanical advantage by running it from the iliac crest directly to the rib on the same side rather than by the Lowman technique. Both Lowman and I had good results after using free fascial grafts in reinforcing the paralysed trunk muscles. In my own series of patients the pelvic obliquity was always improved or even completely corrected. Since the deformity had often existed for many years, extensive release operations and correction by turnbuckle plaster spicas together with a well-leg traction apparatus were necessary preliminaries to the fascial graft. Sometimes a spinal fusion had to be performed in addition to the fascial operation by which to prevent recurrence of the scoliosis from pelvic obliquity. Only in a few patients with unilateral paralysis of the lateral abdominals and quadratus lumborum, operated upon within twelve months, was fascial grafting performed successfully as the initial operation. The graft hypertrophied and could be felt as a strong band running from the ninth or tenth rib to the iliac crest and Poupart's ligament. The lifting effect on the pelvis was accomplished by contraction of the intercostal muscles and consequent elevation of the rib to which the graft was attached. There was occasionally return of power in the abdominal muscles which may have been due to intimate adherence of the graft to the aponeurosis of the external oblique muscle. In a smaller group of patients the fascial graft was performed to correct anterior tilting of the pelvis with increased lordosis from paralysis of the recti abdominis, satisfactory results being secured by running the graft from the symphysis pubis to the sternum and costal cartilages.

During the severe poliomyelitis epidemics in Israel in the summers of 1951–1953 many children under the age of six years suffered extensive paralysis of the abdominal muscles. In caring for them Anatol Axer of Israel was joined for a time by Clark of Leeds and they together conceived the idea of utilising the tensor fasciae latae with its attached ilio-tibial band as an active dynamic transplant, instead of the more static type of free fascial graft.

Their experiences are recorded in this number of the Journal. It was my privilege to observe some of their results and I was so impressed as to use their method in five patients. After the operation there was palpable contraction of the tensor fasciae which added to the effectiveness of the fascial graft. Nevertheless I doubt whether this transplant will be equally effective in correcting forward tilting of the pelvis from bilateral paralysis of the recti abdominis where a free graft running from the symphysis to the sternum would seem to be more efficient. If, however, the transplants devised by Clark and Axer could be performed bilaterally, and could be made to reach the ribs on the opposite side, thus forming a criss-cross pattern, they might serve even more effectively than free grafts. LEO MAYER.

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THE ANTERIOR TIBIAL SYNDROME: A CHRONIC FORM?

A paper by G. E. Mavor in this issue of the Journal describes a patient with chronic, recurrent symptoms apparently arising in the anterior tibial compartment of the leg. Mavor attributes these symptoms to muscle ischaemia in that compartment, postulating the existence of a chronic form of what has come to be styled the " anterior tibial syndrome."

The acute form of this syndrome is now well known. It was first described by Vogt in 1943 and it was very fully considered in this Journal in 1948 by Rowland Hughes. The symptoms follow strenuous exertion rather than injury. Pain and swelling develop rapidly in the affected part of the leg. There is usually impairment of conduction in the lateral popliteal nerve, and obvious ischaemic changes in the anterior tibial muscles have been found at operations. Ischaemic *contracture* has not been seen; the lesion is one of ischaemic *necrosis*.

Mavor bases his concept of a more chronic form of the condition upon one case in which he had " little doubt about the diagnosis." A surgeon who has not seen his patient naturally hesitates to disagree, but with all hesitation it would appear that, if his case is typical of a chronic form of the syndrome, diagnosis must be anything but simple. Pain over the front of the leg after strenuous exercise is so common as to be regarded as a normal response in an untrained person, and even in a trained athlete if he exceeds his physical capabilities. In any patient complaining of such pain, can we fairly attribute the symptom to ischaemia if the only evidence of reduction in blood flow is a difference in the temperatures in the skin of the feet? It is noteworthy that, in Mavor's case, the exposed tissue muscle showed " no ischaemic features " and no evidence of fibrosis or of organisation. It is, of course, made clear that the muscle changes in such chronic cases are not expected to reach actual necrosis, but, in the absence of necrosis or of physical signs indicating it, how can the lesion be diagnosed? How is it to be distinguished from the ordinary pain of fatigue, which pain, though possibly " ischaemic " if the meaning of the word is stretched somewhat, is to be regarded as physiological rather than as evidence of disease?

It is particularly interesting that the symptoms of Mavor's patient subsided after the repair of muscle herniae. In the acute anterior tibial syndrome, swelling of the affected muscle is constant. One might therefore expect herniae through the muscle-sheaths to act like safety valves and to decompress the anterior tibial compartment. Their repair should make matters worse. Indeed, in one reported case (Sirbu, Murphy and White 1944) there were no symptoms until after a muscle hernia had been repaired, though it must be admitted that this case differed in several material ways from that reported by Mavor.

Mavor's paper raises two old questions. First, how is pain produced in striated muscle after exercise? Second, what are the criteria which can justify a claim to have described a new syndrome? The answer to the first must await further research from the physiologists; the answer to the second can probably never be laid down, for we have no convenient Koch's postulates in orthopaedic surgery. I doubt, however, if the criteria presented in Mavor's paper will satisfy his more critical readers, grateful though they will be for an interesting presentation.

D. Ll. Griffiths.

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SURGICAL TREATMENT OF THE KLIPPEL-FEIL SYNDROME

A. BONOLA, MODENA, ITALY

Though we must go back to Herodotus for the earliest account of the mythical race of Acephala (Fig. 1), who were supposed to inhabit the western part of Lybia, we owe to Ulisses Aldrovandi (1522–1605) the suggestion that the " monstrosity " consisted simply of absence of the neck, the head and chest being so closely approximated that the eyes seemed to belong to the chest (Belloni 1950). There is no doubt that the ancient inventors of the myth had seen an example of severe congenital deformity of the cervical spine.

Haller (1743) and Morgagni (1746) described the anatomical features in two such cases with reduction in number and fusion of the vertebrae. But it was not until 1912 that an adequate clinical and anatomical description of this anomaly was given by Klippel and Feil, who regarded the deformity—perhaps wrongly—as a single well defined entity.

FIG. 1
The Acephalus. A sculpture by Nicholaus in the Cathedral of Ferrara (Italy).

The Klippel-Feil syndrome, or congenital osseous torticollis, was studied later by numerous authors, and especially by Bertolotti (1920), who recognised the following essential features: 1) absence or shortening of the neck; 2) limitation or absence of movements of the neck; and 3) a low hair line at the back of the neck (Fig. 2). There might also be other minor features, such as thoracic and cranio-facial asymmetry, flat back, simian deformity of the scapulae, impaired jaw movement, angular cervico-thoracic scoliosis, and occipital platycephaly; and the condition might be associated with congenital deformities in other parts of the body.

According to Bertolotti the anatomical changes seen radiographically include fusion of the vertebrae into one mass, either cervical or cervico-thoracic, hemivertebra, platyspondyly, atlanto-occipital fusion, assimilation of the third cervical vertebra with the axis, transverse segmentation of vertebral bodies and vertical segmentation of bodies and arches, basal segmentation of the odontoid process, partial absence of the sacrum, and total absence of the coccyx.

These diverse manifestations lead me to believe that the Klippel-Feil syndrome should not be regarded as a single clearly defined entity, but merely as a condition of cervical deformity with or without other malformations.

Hitherto the accepted practice has been either to ignore the problem of treatment or to treat the condition symptomatically. With the advances that have been made in surgery I believe that in severe cases the policy of non-intervention should be discarded and an attempt made to correct the cervical deformity with the object of improving both appearance and function. I shall describe the surgical treatment of the Klippel-Feil syndrome under four headings: 1) operations on skin; 2) operations on muscle; 3) operations on nerves; and 4) operations on bone.

OPERATIONS ON SKIN

The Klippel-Feil syndrome is often encountered in the " status " of Bonnevie Ullrich (Turner syndrome), the most striking feature of which is the " pterygium colli " consisting of asymmetrical creases extending from the mastoid process to the acromion, and sometimes involving the muscles and fasciae as well as the skin. Though neck deformities are often present the sex incidence distinguishes this syndrome, which occurs mainly in girls, from

other varieties of the Klippel-Feil syndrome, which are commonest in boys. The three cases of pterygium colli (all in females) that I have studied from the records of Professor Sanvenero Rosselli were all associated with deficiencies of the cervical or thoracic vertebrae (Fig. 3).

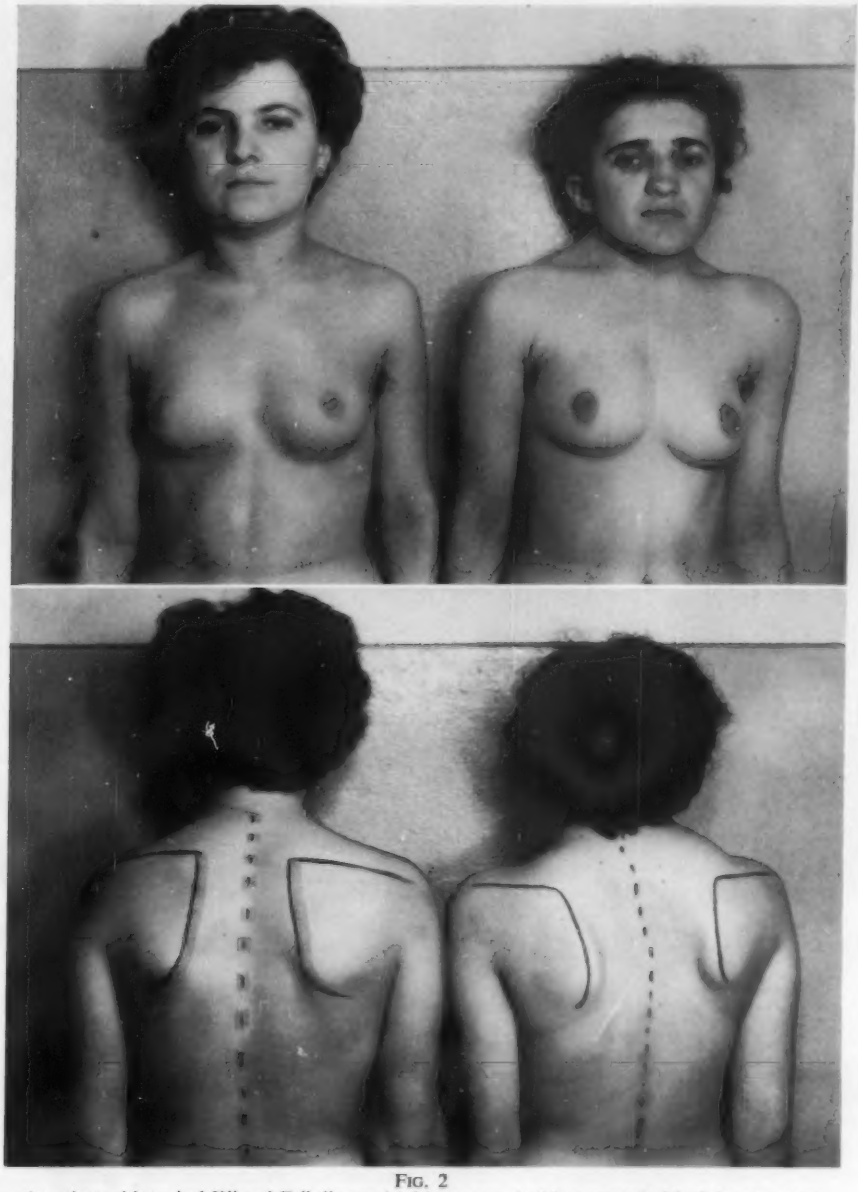

FIG. 2

A patient with typical Klippel-Feil disease (*right*) compared with a normal girl of the same age.

The operation of double z-plasty, with resection of part of the muscle or fascia when necessary, afforded permanent correction of the deformity and allowed greater freedom of neck movement, though movement was still restricted by the bone deformities.

OPERATIONS ON MUSCLE

In some of these cases there is a bilateral contracture of the sternomastoid muscle which is amenable to correction by surgery. In one case, in which I used Putti's technique, the posture and mobility of the neck were much improved. Through a sub-mastoid incision (the scar is hidden by the ear) the mastoid insertion of the sternomastoid muscle is dissected from the bone and a segment three centimetres long is removed. The clavicular and sternal heads of the muscles are divided by subcutaneous tenotomy to avoid leaving scars. Correction is maintained at first by a Schanz collar and later by a plaster case applied with over-correction and retained for two or three months. The correction obtained by this method might well be further improved by stretching or division of other muscles, such as platysma and trapezius, which are frequently also contracted.

FIG. 3

An example of pterygium colli (syndrome of Bonnevie Ullrich) with congenital deformity of the cervical spine before and after plastic surgery (case of Dr Sanvenero Rosselli).

OPERATIONS ON NERVES

Disorders of the spinal cord and compression of nerve roots have been described in the Klippel-Feil syndrome and they doubtless have the same congenital origin. Spasmo-cerebellar syndromes (Serafini and Bertolotti), spastic hemiparesis (Sicard and Sermayez), spastic pyramidal quadriplegia (Guillamme and Mollaret), all with late onset, are examples. Brachial pain is also frequent, as well as painful trophic syndromes of the brachial plexus beginning after the twentieth year of life. Such cases have not so far been treated surgically.

These radicular syndromes, surely connected with the existence of cervical ribs, hidden bifid spines, or congenital deformities of either the radicular or plexus distribution, might certainly be improved by operative removal of supernumerary ribs or by hemilaminectomy or foraminotomy.

It is in fact a notion now commonly accepted, despite its novelty, that congenital deformities affecting the position or distribution of nerve roots can be found in the sacral plexus which may be responsible for severe lumbar pain and sciatica, whether or not they are

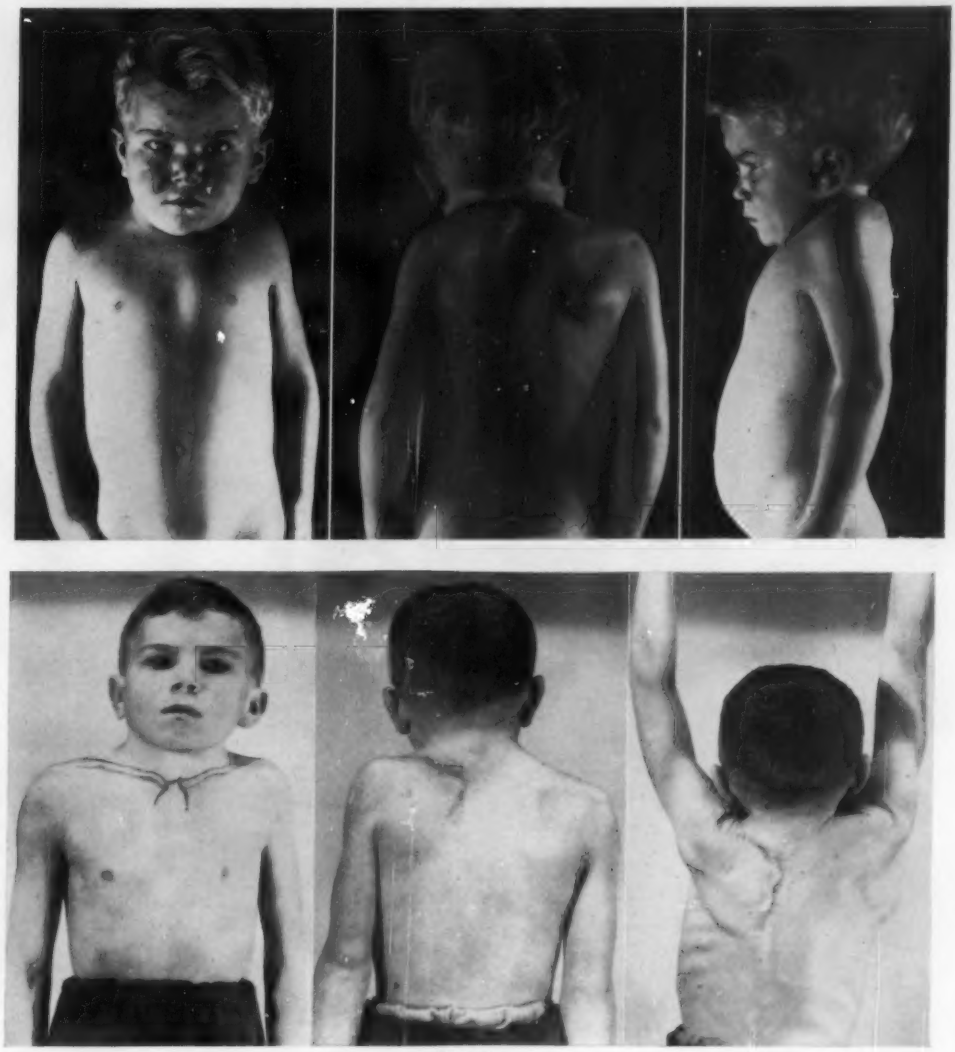

FIG. 4

Klippel-Feil disease associated with left congenital high scapula. The upper photographs show the child at the age of four, before operation. The lower pictures show the child aged nine, five years after operative lowering and fixation of the left scapula.

associated with bony anomalies (spina bifida), or with disturbance of the ligaments or intervertebral discs; and these disorders have been treated successfully by operation.

The same decompressive surgery could be attempted also in the cervical spine; but there the risk and difficulty would be greater.

Although many authors have given a detailed description of the pathological bony

anatomy in the Klippel-Feil syndrome the associated congenital disturbances of the spinal cord have surprisingly been ignored, as have the anomalies in the distribution of the nerve roots which are certainly associated with the deformity in many cases. Anatomical investigations in this direction should bring important results, as they have in disorders of the lumbo-sacral region of the spine.

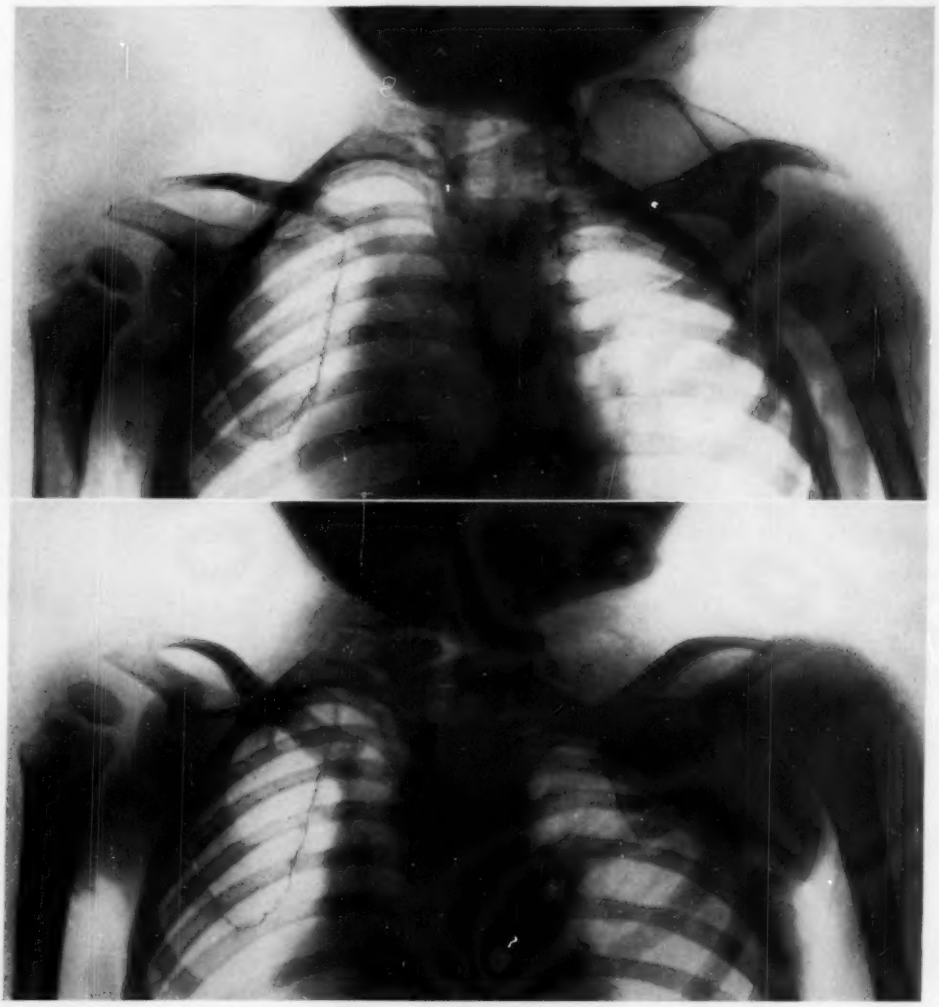

FIG. 5
Same patient as shown in Figure 4. Radiographs before and after operation.

OPERATIONS ON BONES

Various congenital deformities of the shoulder girdle are often associated with the Klippel-Feil syndrome, among which the congenital high scapula is common. In fact this condition is nearly always associated with deformities, however slight, of the spinal column, and, especially when the scapula is fixed to the cervico-thoracic vertebrae through a bony bridge having the form of a rib, it may be responsible for severe deformities with limitation

of movement of the neck and upper limb (Figs. 4 to 5). Operations that I have undertaken for the relief of congenital high scapula have followed Putti's technique, which has always given satisfactory results consistent with the degree of deformity, the age of the patient, and the complications that are sometimes present in severe cases, such as paresis of the brachial plexus. The steps of the operation may be summarised as follows. The incision curves along the vertebral margin of the scapula. The lower part of the trapezius and the upper part of the latissimus dorsi are divided. Below the rhomboid muscle the bony rib-like process that anchors the scapula to the cervico-thoracic vertebrae is isolated and removed. The scapula is freed and severed from its fibro-muscular attachment. It is brought down until its lower angle is fixed to the fifth rib. The reduction of the scapula is maintained by a plaster shoulder spica for some weeks before movements are begun. In one patient operated upon by Putti in 1908 the clavicle also had to be divided before adequate function of the scapula could be secured.

Osteotomy of the spine as described by Smith-Petersen *et al.* (1945) and La Chapelle (1934) and by Delitala and Pais (1952) for the correction of deformities at sites involving less risk could be carried out with extreme caution also for bony torticollis and for the typical cervico-thoracic flexion deformities which, according to some authors, can simulate the late results of spondylitis. Such an operation would sometimes be practicable because the intersomatic joints are often preserved and interrupt the cervico-thoracic synostosis. A cervical osteotomy was in fact carried out successfully by Herbert (1948) and another was undertaken by Law (1951) but the result was poor.

Since in most cases an operation on the cervico-thoracic block is technically impossible I studied the possibility of obtaining a " cervicalisation " of the first thoracic segment by means of bilateral upper thoracic thoracoplasty, with the idea not only of correcting angular deformity but also of forming a new neck. In many examples of the Klippel-Feil syndrome—and always in the more severe cases—the first four ribs are found much above the level of the shoulder girdle, thus giving the typical appearance that has been termed " cervical chest." There is also a high incidence of unilateral or bilateral cervical rib in these cases, as well as of other minor variations such as low implantation of the breasts. The operation that I have devised therefore seems perfectly rational. I was unable to find record of an operation of this nature ever having been tried before. Nevertheless I believed that removal of the upper ribs, which are often supernumerary or congenitally interlinked through synostoses, would not seriously impair respiration, and experience of pulmonary surgery for tuberculosis lent support to this view.

CASE REPORT

The patient was a woman of thirty-two with severe Klippel-Feil syndrome of the classical type. Radiographs showed slight platybasia. The posterior arch of the atlas was assimilated in the occiput, and the body of the atlas was no more than a vestige, scarcely differentiated from the posterior arch. The other cervical vertebrae were fused into a solid block. Bilateral cervical ribs were present, the left one seemingly fused with the first rib. There was a rudimentary cervico-thoracic hemivertebra which appeared to be the cause of a high thoracic scoliosis convex to the right. The patient was able to rotate the head through a few degrees, but all other movements were abolished.

Operation—Partial thoracoplasty was carried out on the right side on May 10, 1954, under local anaesthesia (Fig. 6). Through a right paravertebral incision midway between the spinous processes and the medial margin of the scapula, the trapezius and rhomboid muscles were divided, exposing the first four ribs. The posterior arches of the uppermost three ribs were excised, beginning with the third. The first rib was removed together with the supernumerary cervical rib with which it was fused. The ribs were not disarticulated, but were divided a few centimetres from the joint in order to save time and to avoid excessive lowering of the apex of the lung, which is liable to be anchored to the posterior costo-vertebral angle. The wound was closed completely in layers.

Progress—The post-operative course was uneventful. Immediately after the operation there was a noticeable improvement in the shape of the neck on the right side, and the patient was able to flex and extend the neck for the first time. Radiographs a few days after the operation showed a subcutaneous air-bubble and a haematoma above the lowered dome of the pleura,

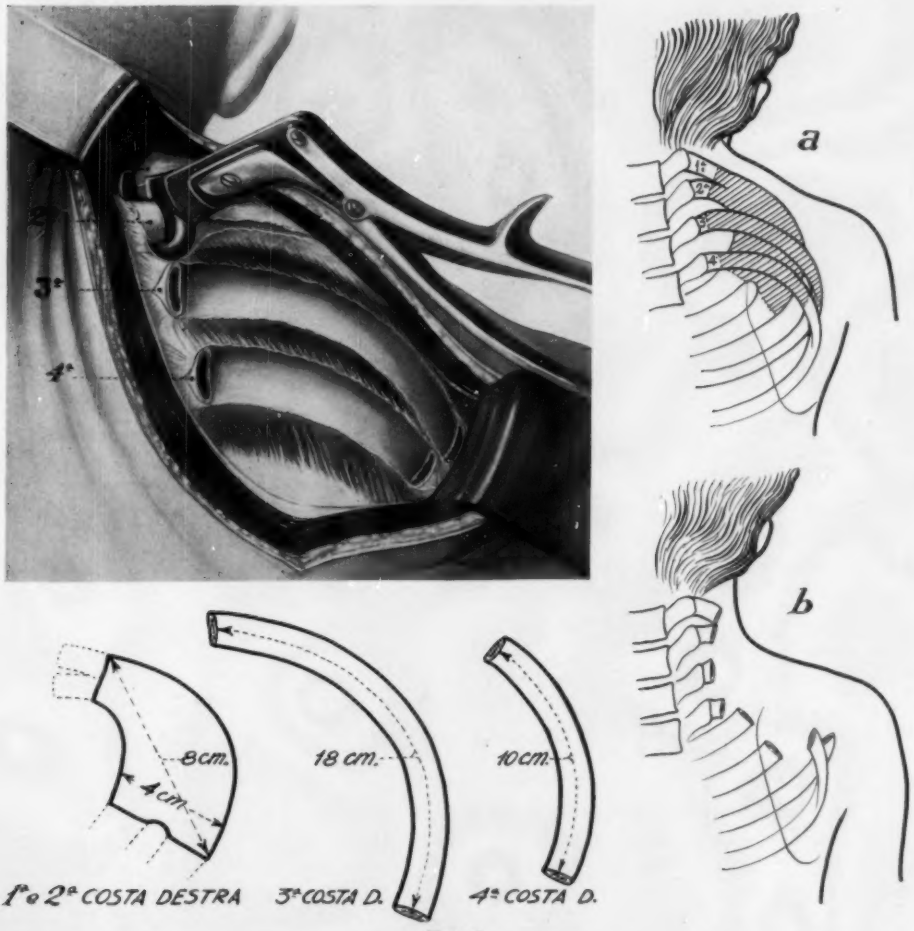

FIG. 6

Diagrams illustrating the operation of right partial thoracoplasty of the seventh cervical and first, second and third thoracic ribs. The diagrams on the right show tracings from radiographs of the neck (*a*) before and (*b*) after right partial thoracoplasty. The diagrams below show the dimensions of the costal segments removed. The seventh cervical and the first thoracic ribs were fused into one large rib 8 centimetres long and 4 centimetres broad. Six months later the same operation was performed on the left side.

evidence that pulmonary function was not damaged. Two weeks after operation a plastic collar was applied to mould the regenerating ribs to the improved contour.

Four months after the first operation the second stage was carried out successfully on the left side, the first, second and third ribs being resected under local anaesthesia.

The patient was discharged from hospital ten days after the second operation and after a further month she was able to return to work. In the meantime she was treated by physiotherapy, with massage and daily cervical suspension for half an hour.

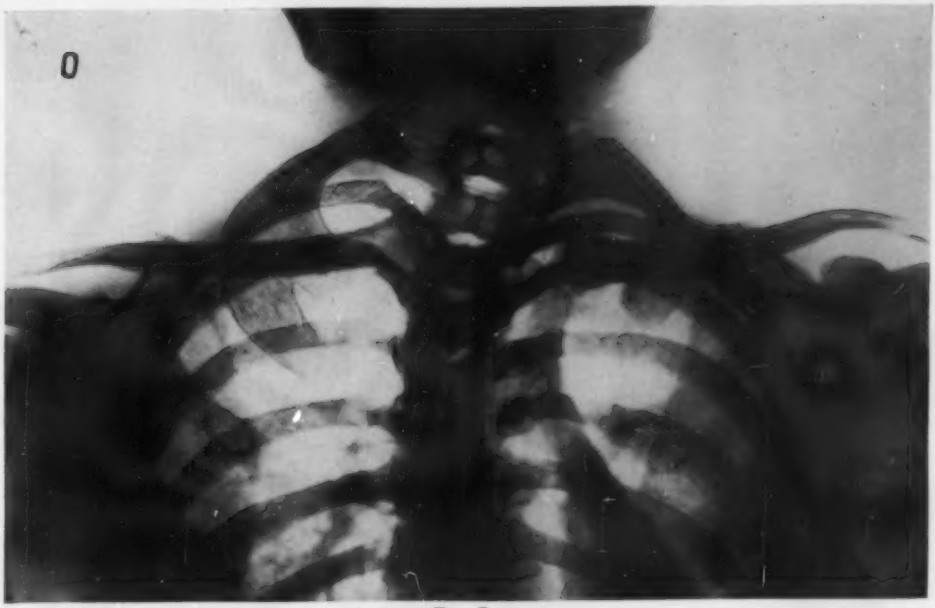

FIG. 7
Radiograph of the upper thorax before operation.

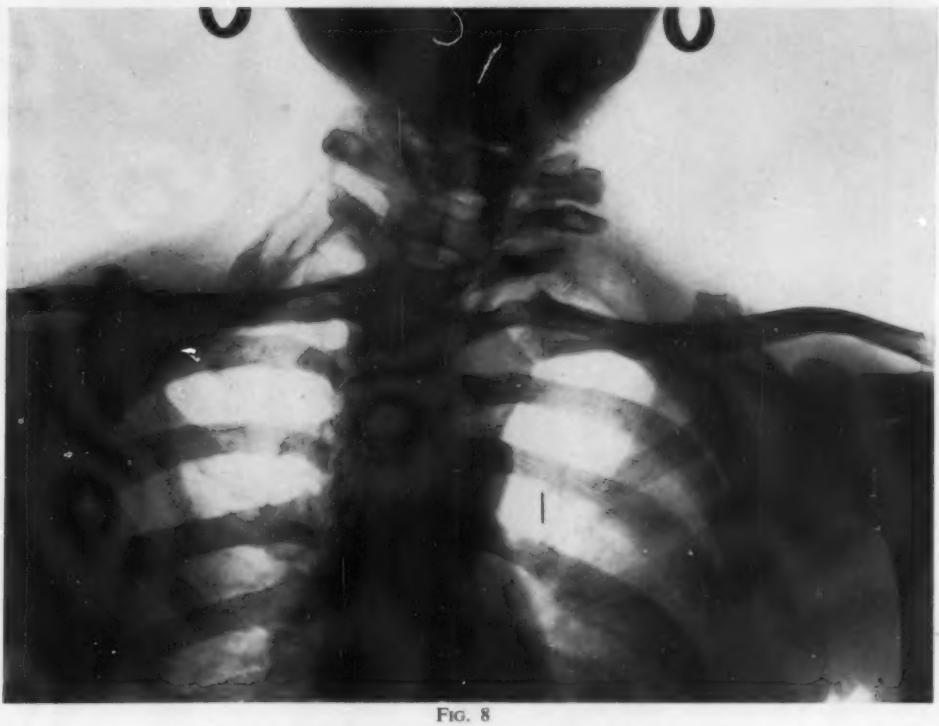

FIG. 8
Radiograph of the upper thorax after bilateral partial thoracoplasty.

At follow-up examination four months after the second operation the patient's general condition was good. She had gained weight, and did not complain of any difficulty with respiration. Spirometry was 1,060 cubic centimetres, scarcely lower than before operation. Rotation, flexion-extension, and lateral flexion at the cervico-thoracic junction allowed good

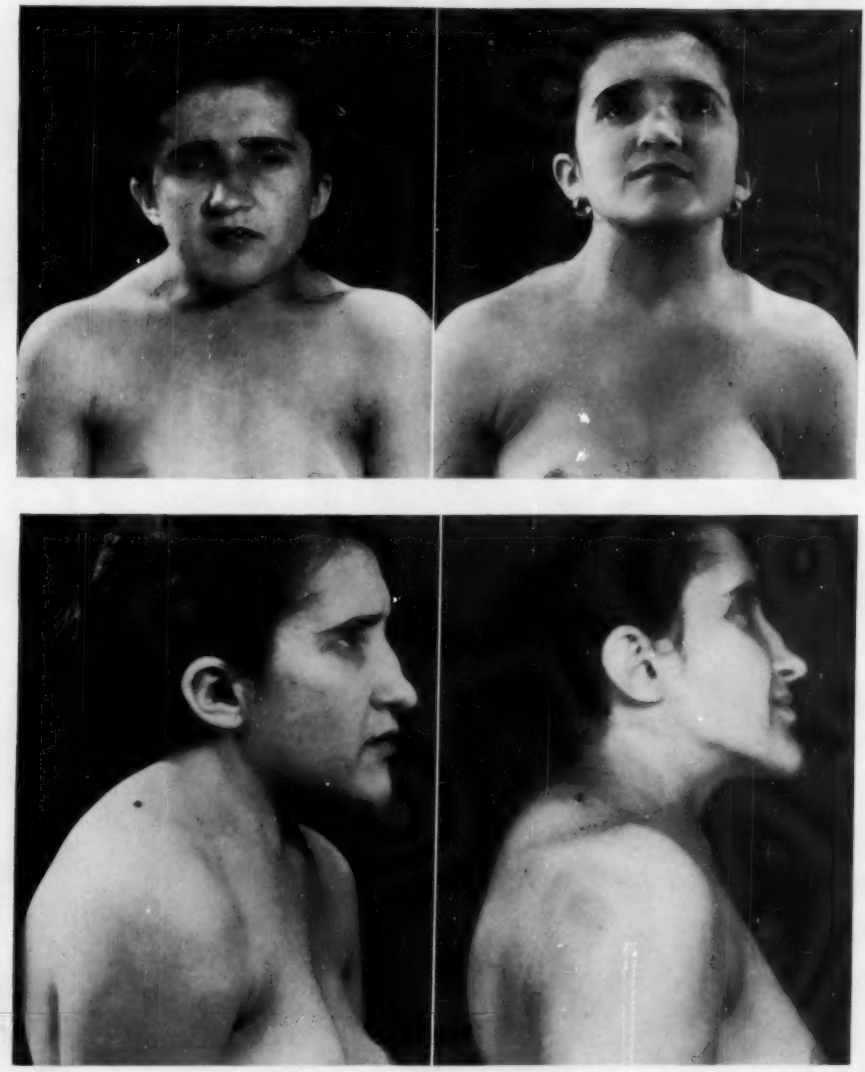

FIG. 9
The patient before and after operation.

mobility, a little less than the normal. The scoliosis was also improved. Radiographs showed that with the lowering of the pulmonary apices and the disappearance of the " cervical thorax " the uppermost three thoracic vertebrae, freed from the ribs, had acquired the appearance and function of cervical vertebrae (Figs. 7 and 8). Traces of periosteal ossification on the right did not affect the shape of the new neck (Figs. 9 and 10).

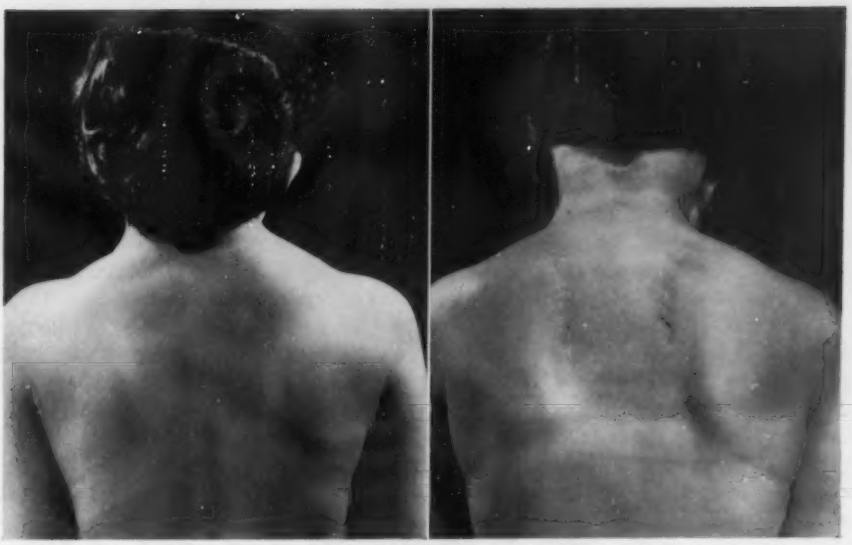

FIG. 10
Back view of the patient before and after operation.

Comment—I believe that the method of treatment described here is free from serious risk if performed with a careful technique. It provides appreciable correction of an ugly congenital deformity which was hitherto considered unsuitable for surgical treatment. A larger experience of the method, though not easily obtained because of the rarity of these cases, will probably bear out these optimistic conclusions.

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TREATMENT OF INFANTILE IDIOPATHIC SCOLIOSIS

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Evidence has been presented that idiopathic scoliosis appearing before the age of two has certain distinguishing features which sustain the identification of a special group called infantile idiopathic scoliosis (James 1951, Scott and Morgan 1955). The principal identifying points are: thoracic curve with apex to the left; no sex predominance; steady and predictable deterioration—all in this category proceed to a severe deformity. The principal variation depends on the preponderating direction of the curve. There is in all a combination of increase in both the antero-posterior and lateral curves. This increase may be evenly balanced, or it may lead to what is principally a kyphosis or a pure lateral curve. In either case decompensation is not usually a prominent feature.

Much thought and effort have been devoted to the treatment of individual patients in this group, but because of their relative infrequency and the long period of follow-up required no collective analysis of results has been presented. The series reported here is too small to justify statistical appraisal but it includes certain features which merit attention in the interest of patients with this deformity.

It is perhaps as well to say at this stage that no evidence has been discovered in this analysis, or of a reliable nature in the literature, that any treatment applied to correction or control of the deformity has had any material effect. There is in fact a good deal to suggest that much of the valiant striving has in the long run done more harm that good.

During the course of eighteen years' study of the deformity at this hospital most of the accepted methods of treatment have been applied at different times during the growth period. These include: Murk Jansen bed, frame with lateral pressure, lateral slings, ambulatory jackets of all kinds, prolonged traction, turnbuckle jackets (Risser and Barr types), vertebral epiphysiodesis, and spinal fusion both lateral (somatic) and posterior. The evidence produced by the analysis suggested that certain of the measures, such as prolonged traction in the supine position, temporarily slowed the increase in the deformity but when the treatment was discontinued the graphic analysis showed that the curve soon reached the point that would have been expected if it had continued without interference. This observation applies particularly to those in which the traction was applied at a relatively early age.

RESULTS OF OPERATIVE TREATMENT OF INFANTILE IDIOPATHIC SCOLIOSIS

Between 1928 and 1948 twelve patients with infantile idiopathic scoliosis were treated by spine fusion procedures. By 1952 the average follow-up time since operation was eighteen years.

In the late 1920s Girdlestone, appreciating the poor prognosis of this type of scoliosis, operated on several children at what would be considered to-day a very early age, doing four posterior spine fusions between the ages of six and seven. In 1933 and 1934 he made a direct attack on the vertebral bodies at the apex of the curve by costo-transversectomy, excision of the discs and vertebral epiphyses, and grafting of the vertebral bodies. Three patients were treated by this method, and although the results were disappointing, it is interesting to reflect on the skill of the surgeon who successfully performed such major procedures without the resources at the disposal of modern surgery. It is also important to assess the results of somatic

fusion, because vertebral stapling is now being advocated as a possible method of treatment (Figs. 1 and 2).

Procedures—The various methods and their results are summarised in Tables I to III.

TABLE I

POSTERIOR FUSION OF MAJOR CURVE (SEVEN CASES)

Fusion after extension on a frame			
Case number	Age at fusion	Major curve at time of fusion	Result
1	7	35°	84° (age 28)
2	6	75°	114° (age 29)
3	7	74°	130° (age 28)
4	7	40°	— (died after operation)
5	13	108°	140° (age 18) (died age 29)
6	14	83°	101° (age 16) (died age 20)
7	14	107°	140° (age 21)

Fusion after correction by turnbuckle jacket correction (one case)				
Case number	Age at fusion	Major curve before correction	Major curve at time of fusion	Result
8	12	88°	40°	82° (age 16)

TABLE II

POSTERIOR FUSION OF COMPENSATING CURVE (ONE CASE)

Case number	Age at fusion	Major curve at time of fusion	Result
9	14	109°	128° (age 21)

TABLE III

COSTO-TRANSVERSECTOMY, VERTEBRAL EPIPHYSIODESIS AND SOMATIC SPINE FUSION (THREE CASES)

Case number	Age at fusion	Major curve at time of fusion	Result
10	5	40°	120° (age 23)
11	5	53°	126° (age 14) (died age 17)
12	12	71°	130° (age 24)

These patients can be divided into two groups: those operated upon between the ages of five and seven—six patients; and those operated upon between the ages of twelve and fourteen—six patients.

Fusion between ages of five and seven—In this group the average curve measurement at the time of operation was 53 degrees; and the average measurement at the age of twenty was 115 degrees.

Fusion between the ages of twelve and fourteen—In this group the average curve measurement at the time of operation was 94 degrees; and the average measurement at the age of twenty was 120 degrees.

It can be seen from this analysis that the final results in patients operated upon early are similar to those in which treatment was given between the ages of twelve and fourteen. In the first group the curves progressed despite fusion. In the second a severe curvature was already present at time of operation and at this stage fusion has usually no beneficial result.

The graph in Figure 3 demonstrates that, on average, patients treated by spine fusion progressed at a similar rate to those in whom no operative treatment was afforded (Scott and Morgan 1955).

In only one patient (Case 8) was there substantial evidence that surgery had been beneficial; in this case, although most of the correction obtained had been lost, the deformity did not progress after fusion. In this patient there was a delayed onset of deterioration, and

FIG. 1

FIG. 2

Radiographs of patient treated by costo-transversectomy, vertebral epiphysiodesis and somatic spine fusion (Case 11). Figure 1—At age nine, one year after operation. Figure 2—At age fourteen, by which time the curve had increased considerably.

despite the major curve measurement at the age of twelve (88 degrees) the girl was well developed, and therefore suitable for surgery (Figs. 4 to 7). In most patients the deterioration occurs earlier, and by the age of twelve the deformity of the thoracic cage—with corresponding diminution in vital capacity—may be so severe and so fixed that surgery at that stage is of no value.

There is no doubt that to obtain a successful spine fusion in a young child is difficult, and in those operated upon early some of the fusions may have been inadequate. Nevertheless in one case in which the fusion was certainly adequate (Case 1) the major curve increased despite fusion (Figs. 8 to 10).

From direct radiographic measurements of the graft there is no evidence that the graft increased in length between the ages of seven and twenty-eight years, despite considerable

growth in the vertebral bodies. The intervertebral disc spaces were obliterated and gross rotation of the vertebral bodies occurred; the graft had thickened considerably, and there was no evidence of a pseudarthrosis at any time.

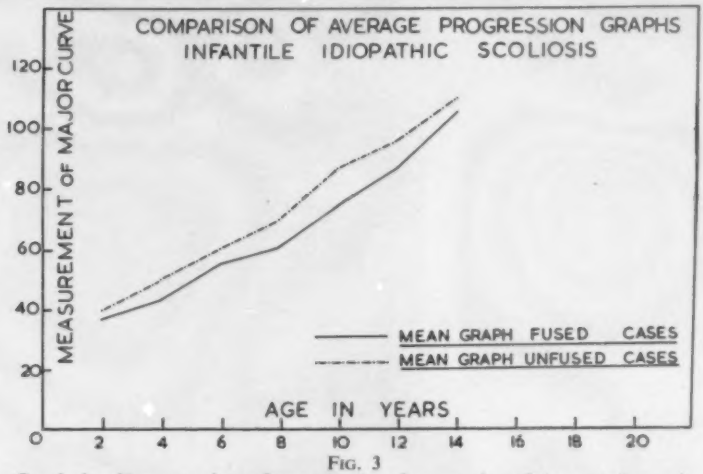

FIG. 3

Graph showing comparison of average rates of progression of the treated cases in this series, and an equal number of untreated cases, observed over a similar period.

FIG. 4

FIG. 5

Case 8. Figure 4—Radiograph at age seven. Figure 5—At age twelve, just before spinal fusion.

FIG. 6

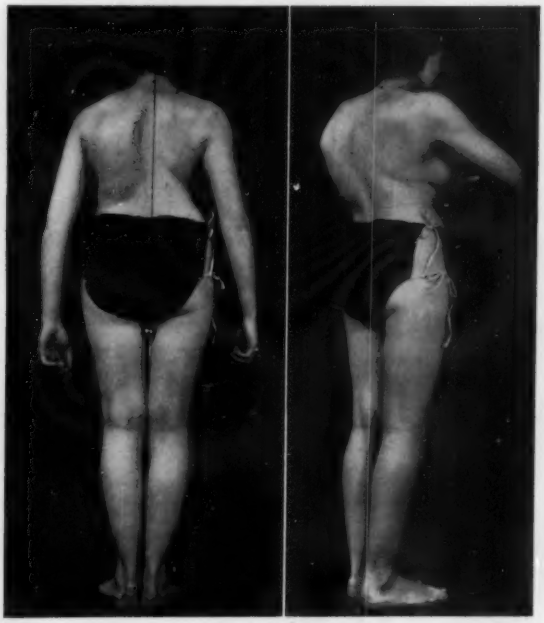

FIG. 7

Case 8. Figure 6—Radiograph at age sixteen, four years after correction and fusion. Figure 7—Photographs taken at the same time. There was satisfactory fusion, after which there was no further deterioration. The clinical photographs show the rather mild deformity, with good compensation; this is due to the delayed onset of deterioration (at seven years the curve measured only 35 degrees).

FIG. 8

FIG. 9

FIG. 10

Case 1. Figure 8—Radiograph at age eight, a year after fusion. Figure 9—At age twelve. Figure 10—At age twenty-eight. Note the increase in the curve, despite a satisfactory graft; and the disappearance of the intervertebral disc spaces.

FIG. 11

FIG. 12

Case 3. Figure 11—Radiograph at age one year. Figure 12—At age seven, after fusion.

FIG. 13

FIG. 14

Case 3. Figure 13—At age thirteen. Figure 14—At age twenty-eight.

In the series published by Ponseti and Friedman (1950) it was reported that after fusion before the age of fourteen spinal growth was diminished (48 per cent) or absent (52 per cent). It was suggested that this was due to failure of growth of the intervertebral discs. We believe that this is a secondary effect, in that the fused area of the spine cannot elongate freely with growth, because of the anchorage effect of the relatively inextensible graft. The vertebral bodies, however, continue to grow at the expense of the intervertebral discs.

In some cases there is evidence that the posterior spine graft may have aided the process of deterioration. This applies particularly to the kyphotic type, in which the graft on the concave side may have a "bowstring" effect, encouraging the production of further deformity (Figs. 11 to 17).

FIG. 15

FIG. 16

FIG. 17

Case 5. Figure 15—At age one and a half years. Figure 16—At age thirteen, after fusion. Figure 17—At age twenty-three. Despite the difference in age of fusion in Cases 3 and 5 (seven years and thirteen years respectively) these two cases have progressed in similar manner, producing the kyphotic type of deformity. The "bowstring" effect described in the text is well illustrated by both cases.

MORTALITY

Four of these twelve patients had died at the time of this report. One of the four died from the operation, and at post-mortem examination the cause of death was found to be mesenteric occlusion; the remaining three deaths were due to pulmonary conditions for which the thoracic deformity could be held directly responsible.

DISCUSSION

In assessing the value of treatment it is desirable to recall the principal symptoms from which these patients suffer and the principal causes of death. The ultimate deformity in these patients is so severe that cosmetic consideration must carry little weight in the preparation of a programme of treatment. In the great majority, since the curve is high and is present from an early age, decompensation in the ordinary sense is not severe. The extreme distortion has its most serious effect on the thoracic cage and the respiratory organs, with a secondary effect on the cardio-vascular system. As we have previously pointed out, the spine is always

seriously shortened and sometimes the growth of the extremities is also much below the average. The vital capacity of the adult with this deformity is often only about 500 cubic centimetres. It is unusual for these patients to complain of pain in the region of the deformity.

The prognosis for life is not good, and death is usually due to the effect on the heart of the distortion of the thorax. Effort angina is a frequent symptom.

Attempts to correct the deformity have failed and have led in many instances to increased rigidity of the thoracic cage and decreased vital capacity. It is apparent that prolonged recumbency or restriction in jackets which decrease thoracic movement and the general activity of the individual, if they fail to prevent progressive deformation of the chest, as they do, cannot fail to add to the effect of the deformity on the respiratory organs.

It seems evident from these observations that in the present state of our knowledge the best treatment for these unfortunate children is to arrange exercises to maintain the mobility of the chest and spine and to increase the efficiency of the respiratory muscles, and to do all that is possible to maintain the general health and vigour of the patients. There are occasional exceptions to this rule—one patient has apparently benefited from spinal fusion as demonstrated in the analysis.

There seems little hope of further progress in this field until some light can be thrown on the etiology of the deformity.

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MULTIPLE EPIPHYSIAL DYSPLASIA

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In 1935 Fairbank described a patient with irregular ossification of several epiphyses, but without the features of any condition then recognised. In 1947 he grouped twenty similar cases under the name of dysplasia epiphysialis multiplex, gave a full description of the clinical and radiological features, and discussed the differential diagnosis from cretinism, dysplasia epiphysialis punctata, chondro-osteo-dystrophy of the Morquio-Brailsford type, dyschondroplasia, osteopoikilosis, osteopetrosis and pituitary gigantism.

The chief characteristics of this dysplasia are irregularity in density and outline of several developing epiphyses, stubby digits and short stature. The number of epiphyses affected is variable, but usually includes those for the femoral and humeral heads. Deformity of the epiphyses is usually permanent, and often causes osteoarthritis later in life. In addition, changes other than in the epiphyses are often seen. Sixty-three patients, whom he assigns to this group, are known to Fairbank (1954), excluding those whose affected epiphyses are too few to be called multiple. Whereas the cases first collected showed little evidence of hereditary or familial influence, many of those now known do so. Those showing hereditary influence are a mother and four children (three brothers and one sister) (Hirsch 1937); a father and son, reported as exhibiting chondro-osteo-dystrophy of the Morquio-Brailsford type, but without the spinal changes typical of this condition, and considered by Fairbank to be cases of multiple epiphysial dysplasia (Wood and Robertson 1943); a mother and twin boys reported as exhibiting punctate dysplasia (Resnick 1943); a mother and son (Fairbank 1947); a mother, two sons and a daughter (Jackson *et al.* 1954); three generations of a family (Maudsley 1955); and a father and son (Maudsley 1955). Those showing familial influence alone are a brother and sister (Barrington-Ward 1912), seven members of one family (Ribbing 1937), two brothers (Emr 1952), three sisters (Waugh 1952), a brother and sister (Watt 1952) and a brother and sister (Maudsley 1955). In addition, unpublished cases known to Fairbank (1954) are a brother and sister, and a second brother said to be affected, two brothers, twin brothers, a girl whose two sisters are said to be affected, and two sisters of a family of ten, of which two others are said to be affected.

The present three cases occur in three generations of one family. In addition, the history indicates that three further members of the family have been affected, one in a fourth generation.

CASE REPORTS

Case 1—A boy aged fourteen. For six years he had limped slightly and the left hip had ached. At the age of ten he had spent some time in bed because of this pain. For the last year it had become more troublesome and the right hip had begun to ache.

Stature 5 feet 3 inches. The left lower limb was half an inch shorter than the right above the knee. Each hip flexed through 130 degrees, and abduction of the left hip was restricted by 10 degrees. The fingers were somewhat stubby (Fig. 16) and there was a slight flexion contracture of the little fingers.

Radiographic examination—Epiphysial or other abnormalities were seen in the hips (Fig. 1), knees (Figs. 4 and 5), feet (Figs. 10 to 12), shoulders (Fig. 13) and hands (Fig. 18). At the elbow the upper end of the radius and the capitulum were irregular. The eleventh thoracic vertebral body was slightly irregular. At the ankle the tibial epiphysial line was convex distally. The skull showed no abnormality.

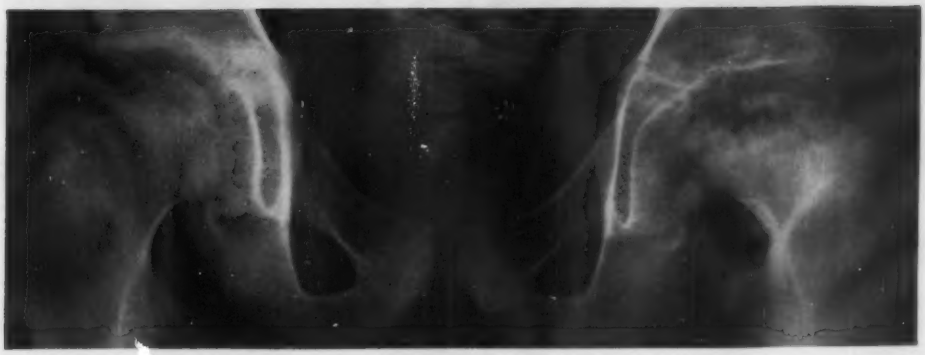

FIG. 1

Case 1—Hips. The left femoral head is mottled and very flattened, and its upper part appears crushed and fragmented. The right femoral head is flattened, but much less, and its texture is normal. The femoral necks are widened. Shenton's line is broken on each side. The left acetabulum is deformed to the shape of the femoral head.

FIG. 2

Case 2—Hips. The femoral heads are grossly flattened and irregular, and the acetabula are shaped correspondingly. The right femoral head contains cysts. Mottled opacities below the femoral necks probably represent loose bodies in the joints.

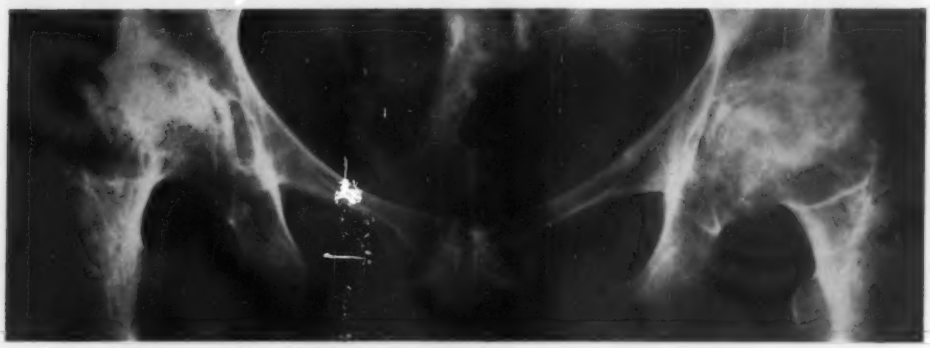

FIG. 3

Case 3—Hips. The femoral heads are somewhat flattened and the joints very osteoarthritic.

FIG. 4

FIG. 5

Case 1. Figure 4—Right knee. The lateral femoral and tibial condyles are mottled. Rounded lips arising from the femoral condyles at the lateral and medial margins of the joint give the condyles an angular shape. The distal end of the femur shows vertical striation. The left knee is similar. Figure 5—Left knee. The patella shows a dense central nucleus within less dense bone. The distal femoral epiphysis bears rounded lips, adjacent to the epiphysial line, more marked in front than behind, and slightly overlapping the metaphysis. The right knee is similar, except for the patellar changes.

FIG. 6

FIG. 7

Case 2. Figure 6—Left knee. The femoral condyles are flattened and angular, and the lateral condyle shows a shallow depression. There is lipping of femur and tibia laterally. The right knee is similar. Figure 7—Right knee. The lateral femoral condyle is flattened. In the left knee this change is less marked.

Case 2—The boy's mother, aged thirty-five. At the age of five, in the gymnasium, it was noticed that she could not sit cross-legged. Since the age of eleven the hips had been painful, but lately had troubled her less. Her activities were not materially restricted.

Stature 5 feet 1½ inches. The left lower limb was half an inch shorter than the right above the knee. Each hip flexed through 100 degrees. Abduction was nil in the right hip, and 20 degrees in the left. Rotation was very restricted. Shoulder abduction was restricted by 30 degrees. There was a slight flexion contracture of the little fingers, but the fingers were not abnormally short.

Radiographic examination—The femoral heads were grossly deformed (Fig. 2), and the femoral condyles were flattened and angular (Figs. 6 and 7). The humeral heads were flattened (Fig. 14). The hands and ankles showed no abnormality.

FIG. 8

FIG. 9

Case 3. Figure 8—Right knee. The lateral femoral condyle is flattened, producing genu valgum. There is osteoarthritis, more marked laterally. The left knee is similar. Figure 9—Left knee. The lateral femoral condyle is flattened. The right knee is similar.

Case 3—The boy's grandmother, aged seventy-one. While she was at school pain began in the right knee and later affected the left knee and both hips. The patient used one stick, limped slightly and could not climb stairs.

Stature was 4 feet 10½ inches. The left lower limb was half an inch shorter than the right. The hip flexed through 90 degrees, and abduction and rotation were very restricted. There was genu valgum. Shoulder abduction was restricted by 30 degrees. The fingers were somewhat stubby, and there was a slight flexion contracture of the little fingers (Fig. 17).

Radiographic examination—The femoral heads were flattened and the hips osteoarthritic (Fig. 3). The knees were osteoarthritic and the lateral femoral condyles flattened (Figs. 8 and 9). The ankle joints were oblique (Fig. 19). The humeral heads were flattened (Fig. 15).

FIG. 10

FIG. 11

Case 1. Figure 10—Right foot. Changes are most marked in the great toe. The epiphysis for the base of the proximal phalanx is irregular, and contains a dense central nucleus. Towards its medial limit is a depression, opposite which lies a depression in the metatarsal head. At each margin of the head of the proximal phalanx a tiny island of bone lies within a depression in the phalangeal head. The lateral island is partly fused with the phalanx. In the fourth toe the epiphysis for the base of the terminal phalanx appears to be annular with a central nucleus. All the metatarsal heads are somewhat flattened. Figure 11—The same foot nine months later. The tiny bone island lateral to the head of the proximal phalanx is completely fused to the phalanx, and the medial island is almost completely fused. The first metatarsal head is lipped medially and laterally, having the appearance of early hallux rigidus.

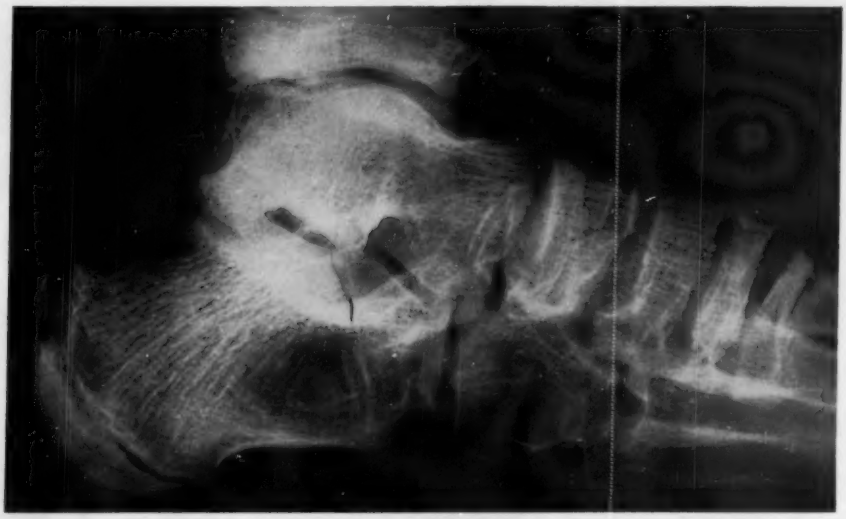

FIG. 12

Case 1—Right foot. A depression occurs in the talar head towards the lower limit of its navicular facet. Other tarsal bones are somewhat irregular. The left foot is similar.

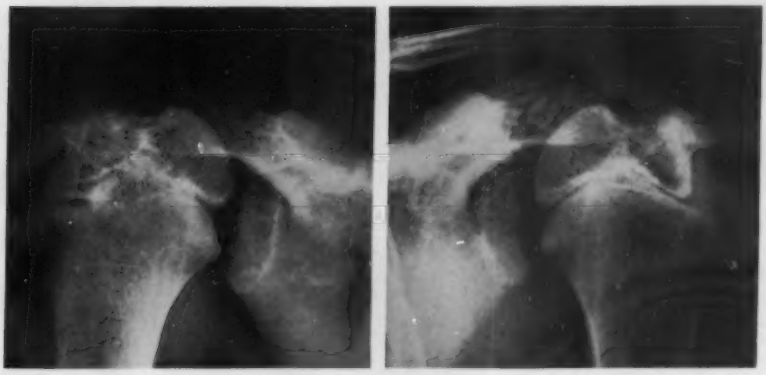

FIG. 13
Case 1—Shoulders. The humeral heads are irregular and the glenoids shallow.

FIG. 14
Case 2—Shoulders. The humeral heads are flattened.

FIG. 15
Case 3—Shoulders. The humeral heads are flattened.

The metacarpal heads were somewhat flattened and the metacarpo-phalangeal joints osteoarthritic. Very large osteophytes arose from the adjacent parts of the second and third lumbar vertebral bodies on the left.

The history of three other members of the family is as follows (Fig. 20).

4. Woman aged eighty. Joint trouble since early childhood. At the age of six she was treated in hospital with lower limb traction and cod liver oil. Stature a little under 5 feet.

FIG. 16
Case 1—Hands. The fingers are somewhat stubby.

FIG. 17
Case 3—Hands. The fingers are somewhat stubby.

5. Woman aged fifty. Hips and knees severely affected. In childhood, diagnosis of coxa vara. Stature 5 feet 5 inches.

6. Man. Onset of hip trouble at boarding school, ascribed to damp bed. Diagnosis of "congenital hip joint." Led an active seafaring life, and remained at sea as Master until the age of fifty-seven, when he died of carcinoma of the lip. The first member of the family known to have been affected.

So far as can be ascertained, the remainder of the family, including the boy's sister, who is a ballet dancer, is unaffected.

FIG. 18

Case 1—Hands. Many of the phalangeal epiphyses show a dense nucleus lying within a ring. Several metacarpal and phalangeal heads show shallow depressions, partly formed by small lips at the margins of the heads. The heads of the proximal and middle phalanges have not arrived at their normal bicondylar form. The metacarpal bases, carpus, and radial and ulnar epiphyses are somewhat irregular.

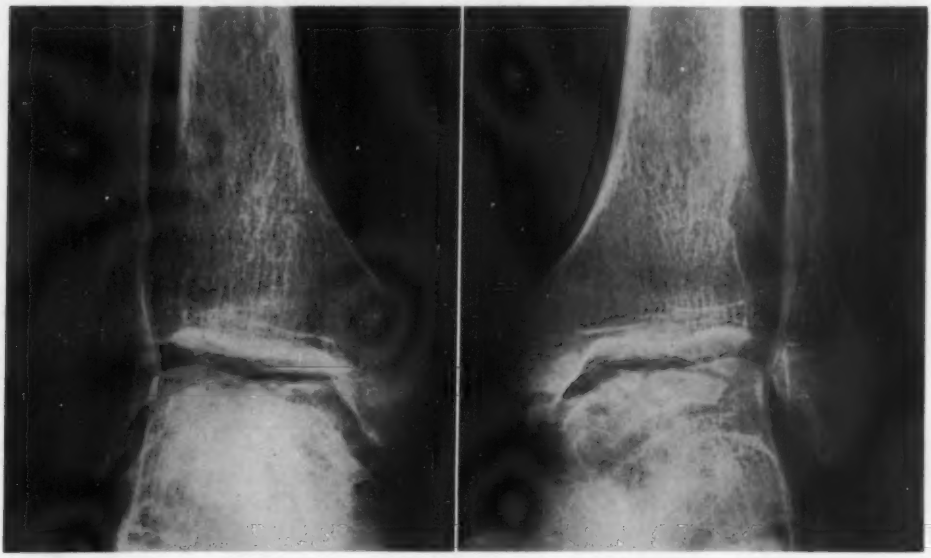

FIG. 19

Case 3—Ankles. The joint lines are inclined obliquely upwards towards the fibulae. The tali are shaped accordingly.

DISCUSSION

Corresponding joints were not affected to the same extent in the three patients examined. The mother's (Case 2) hips were very deformed and contained loose bodies. The boy's (Case 1) left femoral head was grossly flattened. The grandmother's (Case 3) femoral heads showed only moderate deformity, but the hips were very osteoarthritic. The shoulders were affected in each, although the boy's humeral heads did not show the typical flattening. The knees were affected in each, and the lateral femoral condyles of the two older patients were flattened, to the extent of causing genu valgum in the grandmother. Slight flexion contracture of the little fingers was found in all three patients. Otherwise the mother's hands differed little from normal. The other two patients had stubby fingers. Obliquity of the ankles was seen in the grandmother only. The boy's tibial epiphysial lines at the ankle were convex distally.

The stature was short in the three patients examined, but only the grandmother was less than five feet tall.

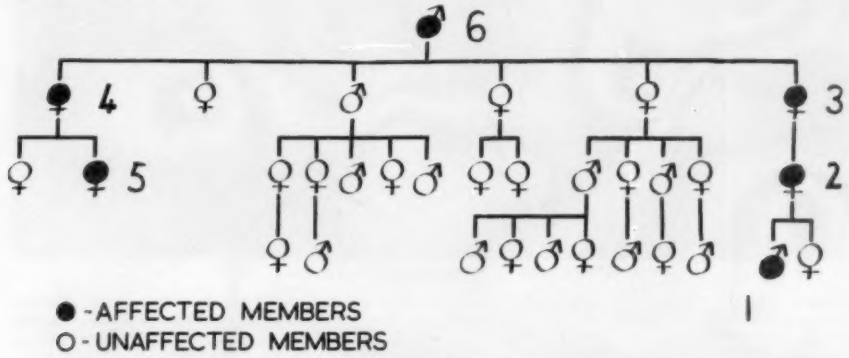

FIG. 20

Family tree. Conjugal partners are omitted. Members 1, 2 and 3 are the boy, his mother and his grandmother. Members 4, 5 and 6 were not available for examination.

Rounded lips arising from the boy's femoral condyles, at the medial and lateral margins of the knee (Fig. 4), gave the condyles the angular shape described by Fairbank (1947). Between each lip and the condyle's normal curve a small depression was formed. A similar appearance was seen in the boy's hands, in the heads of some of the metacarpals and of the proximal phalanges (Fig. 18). The talar heads also showed small depressions (Fig. 12). These changes in hands and feet were extra-epiphysial. All these small depressions were probably filled with cartilage, and they do not necessarily represent irregularities in the joint surfaces.

Small depressions in the heads of the proximal phalanges of the boy's great toes were each occupied by a tiny bone island (Fig. 10), presumably embedded in cartilage. Those islands lying on the lateral sides of the phalangeal heads were beginning to join the phalanges. Nine months later all these islands had fused (Fig. 11). Shallow depressions were noted in the femoral condyles by Ribbing (1937), who also found that they were sometimes occupied by bone islands. Barrington-Ward (1912) noted, in the knee of a girl of nine years, " an apparent loose body with a corresponding depression in the femoral condyle." Watt (1952) described a similar appearance in the superior articular surface of the talus, which he called osteochondritis dissecans, but which might perhaps represent a bone island which had not joined the main bone, rather than a fragment which had separated.

The distal ends of the boy's femora showed vertical striation (Fig. 4). Such localised striation has been seen in several conditions (Fairbank 1951) but apparently not in this dysplasia.

The boy's left patella showed a dense central nucleus surrounded by less dense bone (Fig. 5), an appearance similar to that noted by Fairbank (1947) in the capitular epiphyses of three patients. Several phalangeal epiphyses in the boy's hands (Fig. 18), and those of the proximal phalanges of his great toes (Fig. 10) presented the appearance of a dense central nucleus lying within a ring of less dense bone.

The three patients examined, and the other three affected members of this family, all began to have painful hips in childhood. Fairbank (1947) reported others who had suffered similarly. Further, although function is better than might be inferred from the radiographs of the hips, it is sometimes restricted. This experience is contrary to Waugh's (1952) statement that " in no case of dysplasia epiphysialis multiplex have there been symptoms referable to the changes in the femoral heads," and that " function is invariably good." However, the deformable state of the femoral heads probably lasts too long to make treatment by relief from weight bearing practicable, even if the patient were to seek advice before much deformity had occurred.

SUMMARY

Three cases of multiple epiphysial dysplasia in three generations of one family are described. The history indicates that three further members, one in a fourth generation, have been affected.

My thanks are due to Mr S. L. Higgs for permission to report these cases, to Sir Thomas Fairbank for very kindly giving details of patients showing hereditary and familial influence, and to Mr H. Jackson Burrows for his advice in the preparation of this paper. The house surgeon, Mr E. D. Brooks, helped materially with the family history. The photographs and prints of the radiographs were produced by the Photographic Department of St Bartholomew's Hospital.

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TREATMENT OF OSTEOARTHRITIS OF THE HIP BY OSTEOTOMY

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The ideal treatment for osteoarthritis of the hip should give a stable, painless joint, with a full range of movement and no shortening. Arthroplasties have been devised in an attempt to achieve this, but the results are still unreliable. Consequently it was felt worth while to reassess the results of treatment by upper femoral osteotomy. This paper is based on a review of forty-six femoral osteotomies in forty-five patients, performed at Harlow Wood Hospital between 1933 and 1953.

Patients with osteoarthritis seek advice for several reasons, but pain is practically the only symptom for which the patients gladly undergo operative treatment. At this stage, almost without exception, some degree of fixed deformity is present, either of rotation, flexion or adduction.

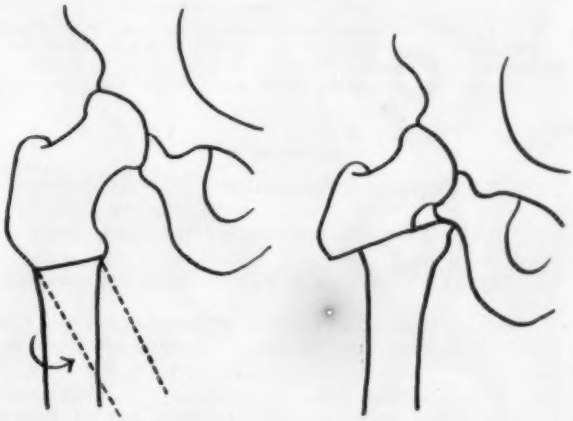

FIG. 1 FIG. 2

Figure 1—Osteotomy as carried out by Malkin. Figure 2—Osteotomy as recommended by McMurray.

THE RATIONALE OF UPPER FEMORAL OSTEOTOMY

In 1935 Malkin, before the British Medical Association at Melbourne, advocated femoral osteotomy for the relief of this condition (Malkin 1936). In that year McMurray (1935) published a paper on the same subject. Malkin carried out his osteotomy at about the level of the lesser trochanter and corrected the deformity (Fig. 1). McMurray (1939), on the other hand, divided the bone obliquely upwards, so that the upper end of the osteotomy was at the lower border of the level of the head of the femur. He then displaced the shaft inwards until it lay below the lower margin of the acetabulum (Fig. 2). He considered this displacement to be an essential part of the operation. More recently Osborne and Fahrni (1950), from the same orthopaedic school, concluded from a review of their cases that marked displacement was a necessity for lasting relief of pain. They considered that a poor result was almost inevitable unless medial displacement of the femoral shaft was adequate, although there might be some temporary relief. Figure 3 shows the degree of displacement at which they aimed, and this is probably accepted by most surgeons as being necessary.

Nevertheless we consider that there must be some further unrecognised factor to account for the unsatisfactory results in Osborne and Fahrni's series. Eighteen of the cases in our series have been followed for between ten to twenty years. Radiographs were not available in three cases, but in the remaining fifteen the displacement of the femoral shaft appeared to be only slight (Figs. 4 to 6). All these eighteen patients, however, had almost complete relief of pain; twelve having none and the remaining six having only slight pain. Indeed one patient, who was seventy-four at the time of her operation thirteen years ago, stated that she had been able to go rough shooting and had even been for a walking tour in Spain. Needless to say, she was an exceptionally determined old lady.

Examination of both antero-posterior and lateral films taken in this series suggests to us that the only essential features of the operation are 1) to divide the bone and 2) to correct deformity. The exact level of the osteotomy and the amount of displacement appear to be of

FIG. 3
Shows extent of displacement considered necessary by McMurray.

secondary importance. It is certain, however, that it is a simple operation and always gives stability if correctly carried out.

RESULTS

Relief of pain—The most important single factor to be considered is the relief of pain. Figure 7 shows the relief obtained in the forty-six cases. It will be seen that in twenty-five cases there was complete freedom from pain; in fifteen there was only slight pain, amounting to some aching in wet weather; and in only six was the pain severe enough to indicate a failure of the operation.

In the cases in which there was a moderate amount of residual pain further examination after these statistics were compiled has shown that two of them now have little or no pain. One patient is at work as a cobbler and the other is a married woman, who is now able to do all her own work and attend to her garden. The decrease of pain in these cases suggests that patients are likely to improve for a considerable time after osteotomy. Of the three

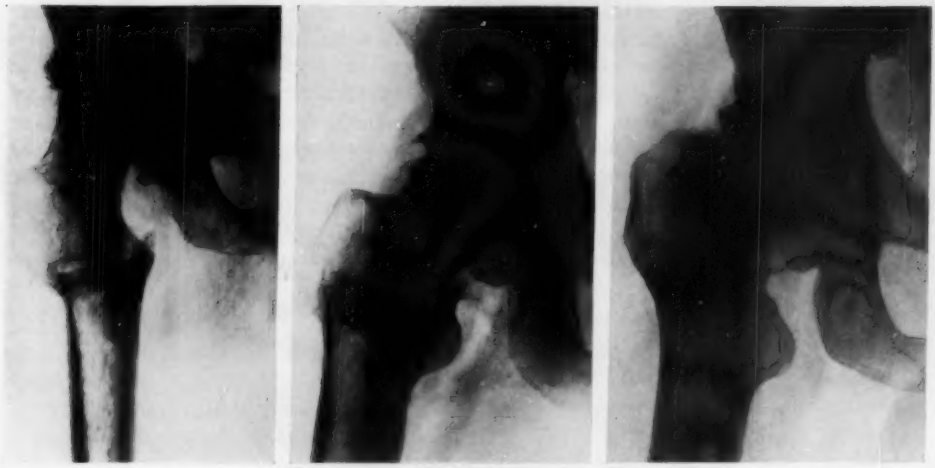

FIG. 4 FIG. 5 FIG. 6

To illustrate only slight displacement.

cases in which there was no benefit from the operation, the osteotomy was found to be ununited in two.

Figure 8 correlates the degree of residual pain with the years since operation. It will be seen that all patients operated upon ten years ago or more have very little pain. Indeed, all the patients with severe or moderate pain have been operated upon within the last ten years. The gap in numbers from three to ten years is largely due to the introduction of various types of arthroplasty.

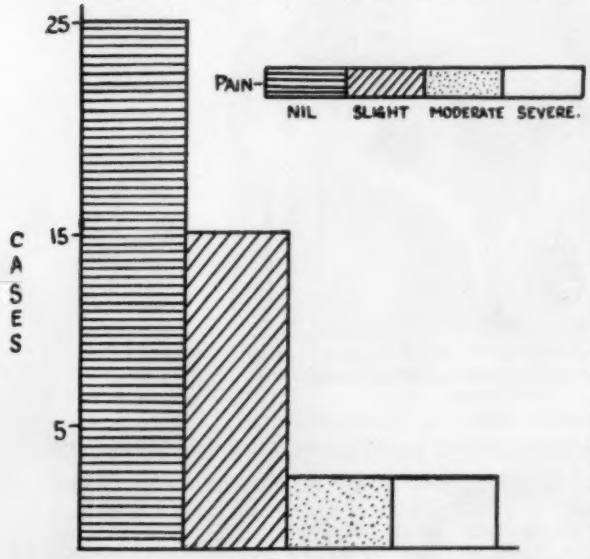

FIG. 7

Diagram shows the degree of residual pain after operation.

Movement—Sacrifice of some mobility is a fairly constant finding after this operation, though the loss is not so great as is generally supposed. Figure 9 shows the movement at the hip when examined at the follow-up. In six cases there was no movement because of either bony or sound fibrous ankylosis; and in nine there was only a degree or two of movement. Eleven patients had between five and nineteen degrees of movement. (Although this does not give a normal gait, it is sufficient to prevent excessive strain being thrown on the back. In patients with osteoarthritis of the spine such a range may be sufficient to prevent the onset of lumbar pain.) Nine patients retained between 20 and 40 degrees of movement and eleven more had over 40 degrees. Thus, twenty patients, or almost half those investigated, retained a satisfactory range. Nearly all patients had between 10 and 30 degrees of fixed flexion, and this appeared to have no relation to the excellence of the results.

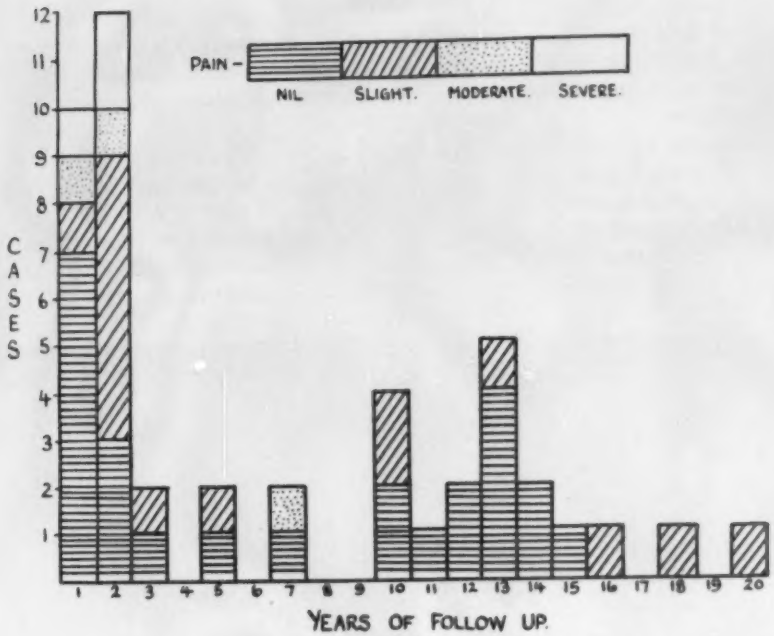

FIG. 8
Diagram shows residual pain in terms of years.

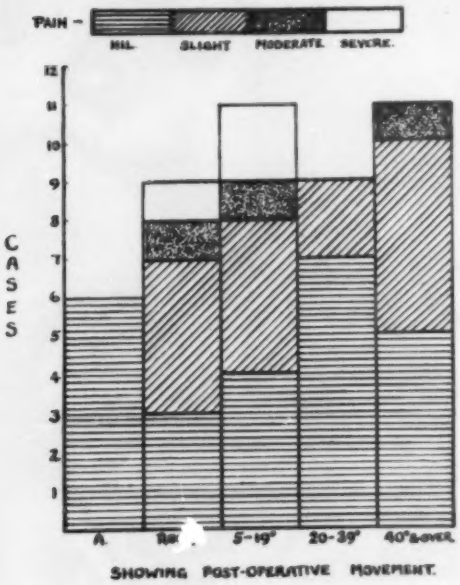

FIG. 9
Diagram shows the amount of hip movement on examination at follow-up.

DISCUSSION

A study of these cases has convinced us that femoral osteotomy is a really worthwhile operation, as some 87 per cent of the patients were largely relieved of their pain and a further 6 per cent were improved. There are, however, some disadvantages which require further discussion as follows.

Long stay in hospital—As most of these patients are elderly, this is a very real problem.

Stiffness of the knee—Despite plaster immobilisation, we found that this was not common, and in this we agree with other writers.

Loss of hip flexion—In 41 per cent of the cases the range decreased by 10 degrees or more (though it should be noted that in 17 per cent the range actually increased). For this reason osteotomy may be contra-indicated in patients with an associated advanced arthritis of the spine.

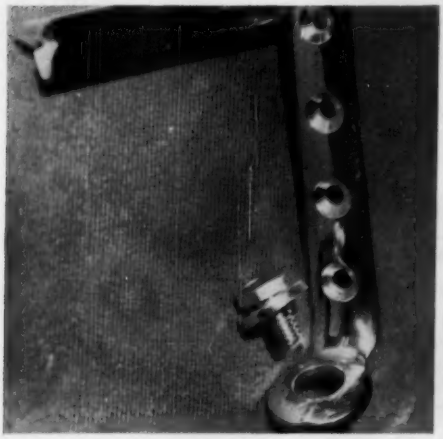

FIG. 10

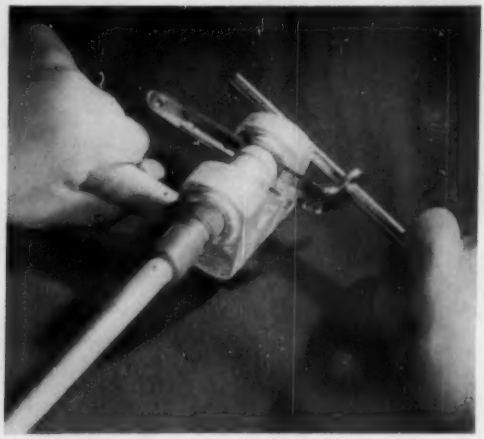

FIG. 11

Figure 10—The type of plate and bolt used for internal fixation. Figure 11—Method employed for producing minor variations in the angle of the neck.

Difficulty of adequate fixation in plaster—In the very obese, it is impossible to obtain a well fitting plaster and patients who suffer from such disorders as asthma or bronchitis are unable to tolerate it.

Internal fixation—The problem of immobilisation has to a large extent been overcome by the use of internal fixation. This has also enabled the operation to be extended to many patients in whom plaster fixation would have been difficult or even dangerous. Internal fixation has been effected by using a nail and plate of modified design. It was found that it was almost impossible to use one of the orthodox types of nail and plate, because once the nail had been passed up the neck of the femur it was impossible to apply the plate to the femoral shaft because of the marked lateral rotation of the proximal fragment and the variation in flexion of the shaft. To overcome this and to allow adjustment in two planes between the nail and plate, a ball and socket junction has been made between them. The hole in the plate through which the bolt passes is much larger than the diameter of the bolt. This allows adjustment between the two before the bolt is tightened. In addition, the angle of the plate is easily altered by holding it in a sterilised hand vice and then levering it by means of a rod through the bolt hole (Figs. 10 and 11).

After operation the patient begins early quadriceps exercises and knee movements. Nursing is greatly facilitated.

FIG. 12
Osteoarthritis before operation.

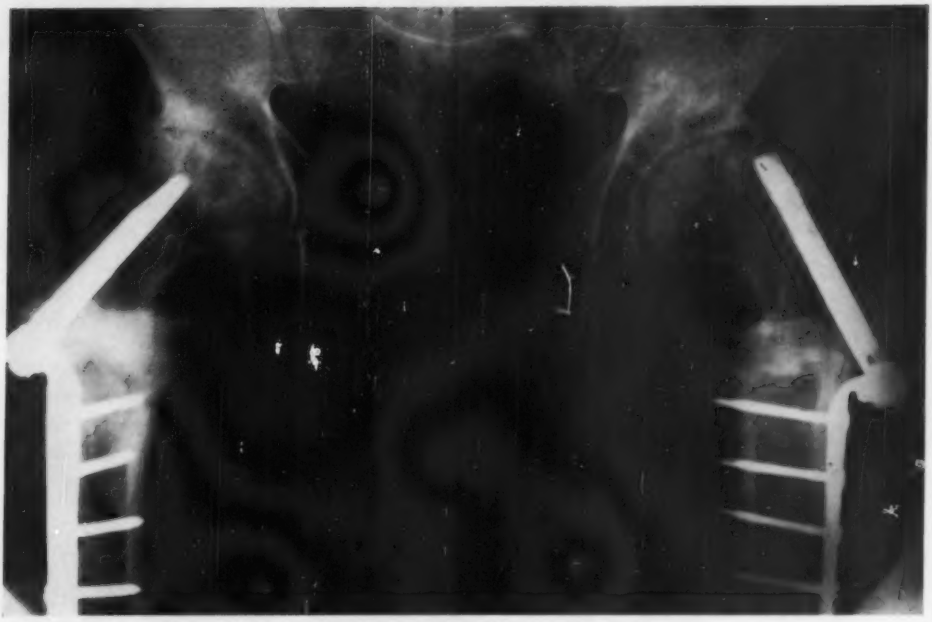

FIG. 13
After operation.

FIG. 14
Further case of osteoarthritis after operation.

Two complications are worthy of mention. The screw which fixes the nail to the plate may loosen. This occurred in two cases, but provided it is recognised early it is a minor procedure to tighten it.

The second is adduction of the limb. Since all movable hips show some tendency to adduct in the immediate post-operative period, slight over-correction of deformity is desirable.

So far, forty-three patients have been treated by osteotomy and internal fixation, and preliminary results have been encouraging. Nearly half of these are fairly recent however and any conclusions would be premature. Twenty-four patients have been followed up and of these there was either complete or partial relief of pain in twenty-three. Only one patient reported neither relief nor benefit from the operation. Three patients with bilateral osteoarthritis requested an operation on the second hip. Illustrative radiographs are shown in Figures 12 and 13. One patient of twenty-six had attempted to commit suicide because of the severity of his pain: twelve months after osteotomy he took a hiking holiday and walked thirty miles in three days without pain (Fig. 14).

SUMMARY

Conclusions based on forty-six osteotomies show this to be a sound pain-relieving operation for osteoarthritis of the hip. The field of operation has been widened and some of the disadvantages have been avoided by nail and plate fixation. Early results from this method are similar to those from osteotomy and immobilisation in plaster, and it seems likely that the relief of pain will be just as enduring.

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A MUSCLE-TENDON TRANSPOSITION FOR PARALYSIS OF THE LATERAL ABDOMINAL MUSCLES IN POLIOMYELITIS

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An attempt to compensate for some of the deficiency of paralysed abdominal muscles was first made by Lowman (1932) when he introduced the method of using a fascial transplant. Mayer (1944) broadened the concept of paralytic deformities from imbalance of the trunk muscles by his description of fixed paralytic pelvic obliquity. This condition may be caused either by abnormalities of the pelvi-femoral muscles such as unilateral contracture of the abductor muscles of the hip, or by unilateral weakness or paralysis of the abdominal muscles and the quadratus lumborum. To improve the strength of the paralysed trunk muscles, Mayer advised that the fascial transplant recommended by Lowman be modified by running it from bone to bone, usually from the iliac crest to the ninth rib. This operation, though not a complete replacement of the paralysed muscles, had a beneficial result as reported in a number of communications (Mayer 1931, 1936). The fascial graft hypertrophied and became strong enough to prevent a recurrence of the pelvic obliquity.

In studying a large group of children paralysed during the severe epidemics of poliomyelitis of 1950 and 1951 in Israel the authors conceived the idea of using the tensor fasciae latae and the ilio-tibial band as an active muscle-tendon transplant. This procedure seemed to have an advantage over the free fascial graft of Lowman and Mayer by the employment of the active muscular power of the tensor fasciae latae. Later it was learnt that a similar transplant had been designed by Hey Groves and practised by Forrester-Brown (1950), but no account of the operation was published. The object of this communication is to record the method, which was independently developed by the authors, to discuss the indications for the operation, and to give some assessment of the results.

FIG. 1
Sites for incisions.

OPERATIVE TECHNIQUE

The first stage of the operation is concerned with the exposure and freeing of the tendinous part of the muscle-tendon transplant which consists of the ilio-tibial band. The band is exposed through a longitudinal incision extending down the lateral aspect of the thigh from half way between the iliac crest and the greater trochanter of the femur to the outer aspect of the knee (Fig. 1). Cleared of the superficial fascia the ilio-tibial band is readily visible,

and is divided transversely as low as possible on the lateral femoral condyle to produce a strip five centimetres wide to be dissected proximally. At the first lifting of the lower end of the transplant it is necessary to cut its deep attachment to the lateral intermuscular septum (between the vastus lateralis and the biceps femoris) which binds the band to the femur. The dissection of the strip proceeds upwards, and after reaching the tensor fasciae latae muscle the dissection is then carried over and above the greater trochanter. At this point in the operation the lower two-thirds of the incision is sutured. Even in small children the operation is easy to perform and there is no need for blood transfusion if care be exercised

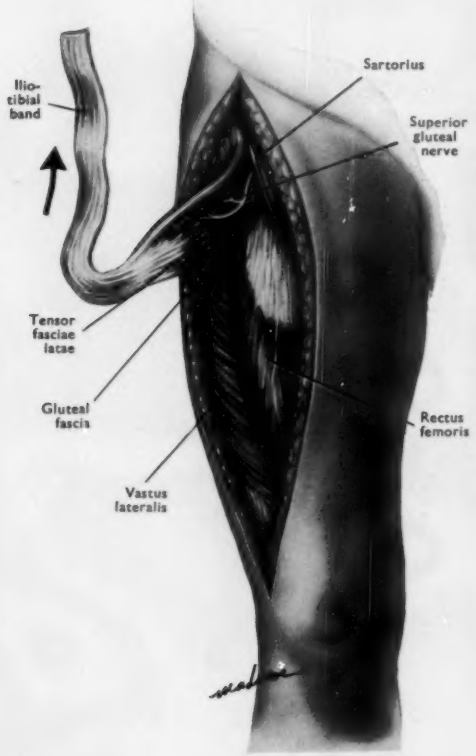

FIG. 2

Figure 2—Isolation and mobilisation of musculo-tendinous transplant.

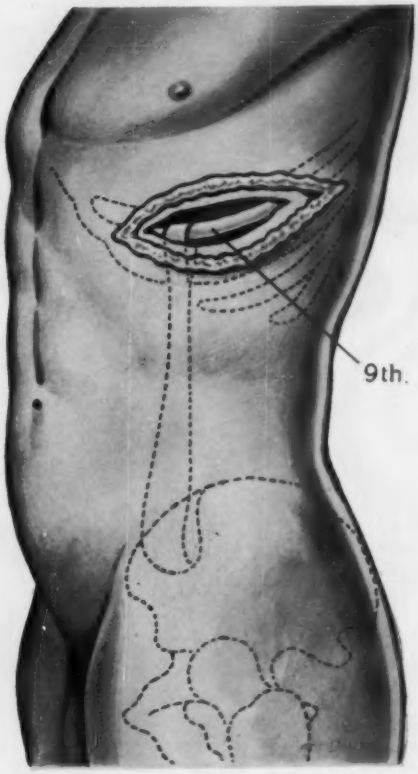

FIG. 3

Figure 3—Transposition of musculo-tendinous transplant.

to cover up the raw areas as soon as possible. In some of the earlier operations there was failure to obtain a dynamic transplant although pre-operative clinical examination had revealed an active tensor fasciae latae. We now always stimulate the muscular part of the transplant with a faradic current by means of a bipolar electrode before proceeding to the second stage of the operation. If the tensor fasciae latae muscle is macroscopically normal faradic stimulation will produce a vigorous contraction. The free end of the ilio-tibial band, supported away from the skin on forceps in about its normal anatomical position, will move proximally about three centimetres when its motor contracts. With the free end of the ilio-tibial band placed over the skin of the lower ribs (which is approximately the site of its future attachment) faradic stimulation of the muscle does not move the end of the ilio-tibial band until the muscle

belly has been isolated from the neighbouring muscles. The tensor fasciae latae must be dissected from the lateral intermuscular septum, away from the gluteal muscles and fasciae and must be separated from the origin of sartorius. The nerve supply of the tensor muscle (the terminal fibres of the superior gluteal nerve) and as much as possible of the blood supply of the muscle must be preserved (Fig. 2). When the proper isolation of the contractile part of the transplant has been achieved it will be found that the excursion of the free end of the ilio-tibial band will be about one-third of that previously noted when the muscle and band were in their normal anatomical positions.

The second stage of the operation is concerned with the exposure of the new site of insertion and with the preparation of the subcutaneous tunnel through which the transplant

FIG. 4

FIG. 5

Figure 4—After operation. Slight right pelvic drop still present when child is suspended and relaxed. Figure 5—Same child in suspension. Right pelvic drop is over-corrected during active abduction of the thigh which causes contraction of the active transplant with its tendon (the ilio-tibial band seen bulging under the skin) attached to the ninth rib to lift the right side of the pelvis.

will run. An incision eight centimetres long is made in the long axis of the ninth rib forwards and downwards from the axillary line (Fig. 1) to expose the underlying rib. After excision of the periosteum of the rib in the same line as the skin incision the bone is stripped on all its surfaces for a distance of six centimetres. A subcutaneous tunnel is now needed between the upper end of the thigh incision and the costal incision. This tunnel can be made quite easily by thrusting a pair of sponge forceps up from below and opening them out until the required area of alveolar tissue is cleared. The tunnel must be wider at the lower end than at the upper to accommodate the greater bulk of the upturned muscle belly of the tensor fasciae latae (Fig. 3). It may be necessary in the second stage of the operation to sever contracted bands about the hip because of the frequency of abduction-flexion contractures in this region in poliomyelitis.

The third stage of the operation consists in threading the transplant through the tunnel and wrapping the free end of the ilio-tibial band round the prepared rib from below, within and over outwards to be sutured upon itself and to the replaced periosteum. The transplant ought to be sutured at moderate tension, with the iliac crest brought sufficiently nearer to the ribs to produce a slight lateral curve of the lumbar spine concave to the same side. Any scoliosis must be corrected as much as possible before the operation, because the transplant is not actively corrective and will only be powerful enough to maintain correction. Electrical stimulation of the tensor fasciae latae at this stage will produce slight tension of the transposed ilio-tibial band under the skin which is palpable and similar to the voluntary action of the muscle that will be demonstrable in a successful result. After closure of the wounds a plaster spica is applied to include both limbs and the trunk from the nipples down; the leg on the side of operation is best fixed in adduction, extension and medial rotation at the hip if an abduction-flexion contracture has had to be corrected. The plaster spica is kept in position for six weeks, and after its removal non-weight-bearing exercises are begun. The first active exercises are directed towards starting activity in the tensor fasciae latae by training the patient in the original action of this muscle—namely abduction with flexion and medial rotation of the hip. After a time the dynamic nature of the transplant ought to be demonstrable by palpable tension occurring in the ilio-tibial band when its motor contracts in conjunction with the active movement of the thigh.

Figure 4 shows a boy suspended after operation on the right side. There is a slight right pelvic drop when the boy hangs relaxed. Figure 5 shows the same boy over-correcting the pelvic drop by active abduction, with flexion and slight medial rotation of the right lower extremity. This movement causes contraction of the active transplant which, by means of its tendon (the ilio-tibial band seen bulging under the skin) attached to the ninth rib lifts actively the right side of the pelvis.

The activities of the transplant must be synchronised with active raising of the pelvis if this action has not been entirely lost or, in the presence of absolute paralysis of the lateral abdominal muscles, an increasing load is placed on the active transplant by applying traction to the leg on the affected side. After six to eight weeks of non-weight-bearing exercises walking with the aid of crutches or elbow-crutches may be started.

DISCUSSION

A chronological analysis of this series of patients is given in Table I. In seventeen out of the twenty-four patients paralysis occurred within the first two years of life; nine infants contracted poliomyelitis within the first year and eight within the second year of life. The interval between the onset of the disease and the operation will necessarily depend often on when the patient first comes under observation. In times of epidemic this interval is likely to be short because under the modern concept of treating the disease the orthopaedic surgeon forms one of the team responsible for the management of the patient from the beginning. In this series of twenty-four patients the longest interval between the onset of the disease and the operation was seven years (because these patients came late under observation) and the shortest was eight months. One patient was operated on within the first year of the disease, twelve within the second year and eight within the third year. The youngest age at the time of operation was twenty-two months. An analysis of the reasons used for the selection of the patients in this series is given in Table II, and it is correlated with the clinical estimation of the results at the latest time of the follow-up that has been possible in view of the recent date of the later operations. The longest follow-up is three years and nine months, the shortest is one year and one month, the average being 23·3 months.

Nineteen patients showed a lateral pelvic tilt before operation, with asymmetrical weakness of the lateral abdominal muscles; fourteen were corrected by the operation, four were improved and one remained unchanged. Bilateral operation for forward pelvic tilt was performed in

only one patient, but the tilt did not alter after the operation although the antero-lateral abdominal muscles gained strength from the "internal splintage" of the abdominal wall. Disparity in leg length was noted in thirteen patients; in seven it was corrected by the operation, in five it was improved, and in the remaining patient there was no change.

TABLE I

TWENTY-FOUR CASES OF MUSCLE-TENDON TRANSPOSITION FOR PARALYSIS OF THE LATERAL ABDOMINAL MUSCLES IN POLIOMYELITIS

Case affected	Side affected	Onset of poliomyelitis	Age at onset		Date of operation	Age at operation		Interval between onset and operation	
			years	*months*		*years*	*months*	*years*	*months*
1	Both	June 1950	1	7	Oct. 1951 Jan. 1952	3	0	1	4
2	Left	May 1950	5	0	Nov. 1951	6	6	1	6
3	Right	June 1951	1	2	Feb. 1952	1	10	0	8
4	Right	June 1950	2	0	Mar. 1952	4	0	1	9
5	Right	May 1950	0	10	May 1952	2	10	2	0
6	Right	Dec. 1951	3	9	Jan. 1953	4	10	1	1
7	Right	Dec. 1951	2	0	Feb. 1953	3	2	1	2
8	Right	Aug. 1951	1	3	July 1953	4	2	2	11
9	Left	May 1952	0	9	Aug. 1953	2	0	1	3
10	Right	June 1951	0	10	Aug. 1953	3	0	2	2
11	Right	June 1946	29	0	Aug. 1953	36	0	7	0
12	Left	— 1951	1	0	Nov. 1953	3	0	2	0
13	Right	Nov. 1951	0	6	Nov. 1953	2	6	2	0
14	Right	Dec. 1951	4	6	Nov. 1953	6	5	1	11
15	Left	June 1951	1	8	Dec. 1953	4	2	2	6
16	Left	June 1947	2	0	Mar. 1954	9	0	7	0
17	Right	Jan. 1952	0	5	Mar. 1954	2	6	2	1
18	Right	Oct. 1952	1	0	Mar. 1954	2	4	1	4
19	Left	Nov. 1951	0	11	May 1954	3	6	2	6
20	Right	June 1951	1	5	May 1954	4	4	2	11
21	Right	June 1952	2	5	June 1954	4	7	2	0
22	Right	Apr. 1952	0	6	June 1954	2	8	2	2
23	Left	Oct. 1951	3	6	June 1954	6	3	2	9
24	Left	Oct. 1949	2	5	Aug. 1954	7	2	4	9

Thoraco-pelvic stability and gait were materially improved in eleven patients, and in ten of these the transplant was active. In the patient whose transplant was passive three-point walking was successfully changed to four-point walking because he is able to hang the right side of the pelvis from the ipsilateral ribs when using crutches, and progression is achieved by a rotatory movement of the thorax which enables him to swing his right foot through

TABLE II

INDICATIONS AND RESULTS OF OPERATION

Case number	Side affected	Indications	Follow-up *years*	*months*	Result
1	Both	Weak lateral abdominals. Forward pelvic tilt. Increased lordosis. Thoraco-pelvic instability	3	9	Abdominals much improved. Tilt unchanged. Lordosis less. T.-P. instability less. Both transplants active
2	Left	Weak left lateral abdominals. Left pelvic tilt. Scoliosis, apex L.1, partly fixed. Left leg longer by 3½ centimetres. Unable to walk	3	8	Transplant weak. Pelvic tilt improved. Scoliosis slightly worse. Disparity in leg length reduced to 1 centimetre. Can walk in braces when supported by elbows
3	Right	Weak left lateral abdominals. Right pelvic tilt. Scoliosis, apex L.2, partly fixed	3	5	Transplant passive. Pelvis level. Scoliosis slightly worse. Walks (braces and crutches)
4	Right	Weak right lateral abdominals. Right pelvic tilt. Right leg longer by 1½ centimetres. Thoraco-pelvic instability. "Screw walking"	3	4	Transplant active. Pelvis level. Disparity in leg length reduced to 1 centimetre. T.-P. instability much less. "Screw walking" much less and can run
5	Right	Weak right lateral abdominals. Right pelvic tilt. Right leg longer by 2½ centimetres. Cannot walk	3	2	Transplant weak. Pelvis level. Leg length equal. Walking with limp owing to subluxation hip
6	Right	Weak right lateral abdominals. Right pelvic tilt. Right leg longer by 2 centimetres. Thoraco-pelvic instability. Scoliosis, apex T.9–10. Awkward gait. Cannot actively raise right pelvis	2	6	Transplant weak. Pelvis level. Leg length equal. Scoliosis worse. Gait improved. Can actively raise right pelvis
7	Right	Weak right lateral abdominals. Right pelvic tilt. Right leg longer by 2 centimetres. Scoliosis, apex T.12, pliable. Unable to raise right foot off ground when walking	2	5	Transplant active. Pelvis level. Leg length equal. Scoliosis unchanged. Can raise right foot off ground
8	Right	Weak right lateral abdominals. Right pelvic tilt. Right leg longer by 2 centimetres. Scoliosis, apex L.3, fixed. Walks with circumduction on the right	2	0	Transplant active. Pelvic tilt slightly less. Disparity in leg length reduced to 1½ centimetres. Scoliosis unchanged. Gait improved
9	Left	Weak left lateral abdominals. Left pelvic tilt. Scoliosis, apex T.12	1	11	Transplant passive. Pelvis level. Scoliosis unchanged
10	Right	Weak right lateral abdominals. Right leg longer by 2 centimetres. Right pelvic tilting. Few steps (braces and crutches). Scoliosis, apex L.4, partly fixed	1	11	Transplant weak. Pelvis level. Leg length equal. Walks much farther and better. Scoliosis unchanged
11	Right	Weak right lateral abdominals. Right pelvic tilt. Right leg longer by 2 centimetres. Can hardly walk (braces and crutches); cannot lift the right leg off the ground	1	11	Transplant passive. Pelvic level. Leg length equal. Walks better and for longer distances
12	Left	Weak left lateral abdominals. Scoliosis, apex L.4, pliable	1	8	Transplant active. Scoliosis unchanged
13	Right	Weak right lateral abdominals. Right pelvic tilt. Scoliosis, apex L.2–3, pliable	1	8	Transplant active. Pelvis level. Scoliosis slightly improved. Walks (braces and crutch)
14	Right	Left leg longer by 2 centimetres. Scoliosis, apex T.11, pliable. Thoraco-pelvic instability. Walks (braces and crutches)	1	8	Transplant active. Disparity of leg length reduced ½ centimetre. Scoliosis unchanged

TABLE II—*continued*

Case number	Side affected	Indications	Follow-up *years*	*months*	Result
15	Left	Weak left lateral abdominals. Left pelvic tilt. Left leg longer by 3 centimetres. Scoliosis, apex L.3, pliable	1	6	Transplant passive. Pelvis level. Leg length equal. Scoliosis slightly improved. Walks (braces and crutch)
16	Left	Weak left lateral abdominals. Left pelvic tilt	1	4	Transplant active. Gait improved.
17	Right	Right leg longer. Scoliosis, apex T.12, partly fixed	1	4	Leg length equal. Transplant passive. Scoliosis slightly worse. Walks
18	Right	Right pelvic tilt. Scoliosis, apex L.1, pliable	1	4	Transplant active. Pelvis level. Scoliosis unchanged. Walks (brace and crutch)
19	Left	Weak left lateral abdominals. Left pelvic tilt. Left leg longer. Scoliosis, apex L.2, partly fixed	1	2	Transplant passive. Pelvis level. Right leg longer from contracture of iliotibial band. Scoliosis worse. Walks between parallel bars (braces).
20	Right	Weak right lateral abdominals. Right pelvic tilt. Scoliosis, apex L.1–2, partly fixed. Defective gait	1	2	Transplant active. Scoliosis slightly improved. Pelvic tilt improved. Gait improved
21	Right	Right leg longer by 1 centimetre. Scoliosis, apex L.4–5, partly fixed. Walks very badly	1	1	Scoliosis unchanged. Transplant active. Gait improved
22	Right	Weak right lateral abdominals. Right pelvic tilt. Scoliosis, apex L.2–3, partly fixed	1	1	Transplant passive. Pelvic tilt improved. Scoliosis slightly improved
23	Left	Weak left lateral abdominals. Left pelvic tilt. Scoliosis, apex L.2–3. Dips to left when walking	1	3	Transplant active. Scoliosis corrected (improved). Still dips when walking. Sits up with more ease
24	Left	Weak left lateral abdominals. Left pelvic tilt. Scoliosis, apex L.1–2. Can just walk (braces and crutches)	1	1	Transplant active. Scoliosis unchanged. Walking no better.

forward. The only disturbing feature seven months after operation was pain localised to the costal attachment of the transplant. Radiographs revealed that the insertion of the transplant was slowly working its way through the rib and there was a considerable amount of heterotopic bone at the site of trauma. When examined again two years after operation this patient was free from pain.

Scoliosis was measured on radiographs of the spine taken routinely at three-monthly intervals in each child showing any tendency to a spinal deformity, with the patient lying supine.

In assessing post-operative correction of scoliosis a curve that differed from the pre-operative one by only a few degrees was defined as "unchanged" since a small difference is within the margin of error in repeating the position of the child—those with differences of about 10 degrees are described as "slightly worse" or "slightly improved." Those with differences exceeding 10 degrees are defined as "improved" or "worse." Actual grading of scoliosis in degrees has been omitted from the tables. Scoliosis was estimated also from comparison of clinical photographs.

In nineteen patients there was scoliosis before operation and five of them improved, nine remained unchanged, and in five the curve continued to deteriorate after operation. In the five patients who improved three of the transplants were active and two passive; all had a correctable scoliosis before operation with the apex at L.3. One of these children has been wearing a Milwaukee brace for two years. Of the nine unchanged eight had active and

FIG. 6

FIG. 7

Figure 6—Before operation. Right pelvic drop when the child is suspended and relaxed. Figure 7—After operation. Right pelvic drop is corrected. The child can lift the right side of the pelvis by lifting the ipsilateral thorax because it is a passive transplant.

FIG. 8

FIG. 9

Figure 8—Before operation in suspension. Pelvic drop to the left and scoliosis. Figure 9—After operation in suspension. Scoliosis almost corrected with active abduction of the thigh which causes a lift of the pelvis on that side through the active transplant which can be seen bulging under the skin.

one a passive transplant and the apex of scoliosis in these lay between T.12 and L.4; four of them had a partly fixed spinal curve before operation, and five a pliable one, and one has been wearing a Milwaukee brace for one year.

Figure 6 shows that when the child was suspended before operation there was an evident scoliosis; it was caused by weak right lateral abdominal muscles. Figure 7 shows that after operation the right pelvic drop was corrected. This child lifts the right side of the pelvis by raising the thorax to which the passive transplant is attached.

Figure 8 shows a child before operation in hanging position and the pelvic tilt and scoliosis can be clearly seen. Figure 9 shows the same child after operation, again in the same suspended position and performing an active abduction of the thigh which causes contraction of the tensor fasciae latae and tension of the ilio-tibial band (both can be seen bulging under the skin) resulting in active lifting of the pelvis on that side and correction of scoliosis.

Of the five children whose scoliosis deteriorated after the operation two became seriously worse. One of them had a weak transplant fixed to the ninth rib, which, most unfortunately, corresponded with the apex of the scoliosis (T.9–10, Case 6) and the other one had a passive transplant for a partly fixed scoliosis (Case 19). The remaining three patients, who deteriorated only slightly, had before operation either a partly fixed scoliosis or a passive transplant, or both.

Analysis of these nineteen children suffering from scoliosis reveals that satisfactory results were obtained if scoliosis was correctable before operation, if its apex lay not above T.12* and the transplant was active.

The results obtained in this limited series suggest that the operation can, at least temporarily, improve, check or slow down the relentless progress of paralytic scoliosis in children who contracted poliomyelitis during the first year of life. Proper application of this operation may therefore allow such children to reach the age in which fusion of the spine can be performed with much better chance of a sound union and without suffering from such a crippling scoliosis as otherwise they might.

CONCLUSION

The important gains from operation are the improvement in thoraco-pelvic stability, by establishment of a dynamic bridge between the two elements, and the improvement in the balance of asymmetrically paralysed abdominal muscles.

1. *Lateral pelvic tilt*—This applies only when the tilt is caused by weakness of the lateral abdominal muscles of one side which may be associated with weakness of the ipsilateral quadratus lumborum. Such tilts are often combined with abduction contractures of the related hip which will require correction during the operation. An active ilio-tibial band transplant will improve the power of the weak lateral abdominal muscles and quadratus lumborum, help to maintain the correction of the tilt and adjust the disparity in leg length caused by the tilt.

2. *Defective gait*—Lurching gait is mostly caused by weakness of the gluteus medius of one or other side, but the lateral abdominal muscles are also concerned. When the gluteal muscles are intact there is still an alteration in the gait if the lateral abdominal muscles are weak. Under such circumstances in order to swing the foot forward on the affected side, the pelvis, although supported by the opposite gluteus medius, still requires assistance from the lateral abdominal muscles of the affected side. These weak abdominal muscles are supplemented by throwing forward the same half of the body and at each step there is a "screw like" motion of the trunk. In so far as the operation adds to the power of the lateral abdominal muscles the gait can be assisted. In the absence of all power in the lateral abdominal muscles and the gluteals the operation has a place in facilitating the use of crutches and braces.

* In a recent child not included in this series the free end of the ilio-tibial band was inserted into the sixth rib because the apex of scoliosis lay at T.8–9. The early result is good.

3. *Scoliosis*—The operation can help in so far as it maintains correction of pelvic tilt. Weakness of lateral abdominal muscles is usually one of the factors in development of the lumbar or lumbo-dorsal scoliosis. By strengthening of these muscles the deformity may be halted, its progress retarded or possibly correction may be achieved.

It is plain that this muscle-tendon transplant cannot be regarded as an adequate replacement for completely paralysed lateral abdominal muscles. It is however an adjuvant to the means employed to diminish the disability of the patient who is so seriously incapacitated that bulky apparatus is required for achievement of any sort of walking. When the gluteal muscles are intact the transplant is able to give material assistance to severely paralysed lateral abdominal muscles and to restore the relatively minor defect in the gait. Muscle imbalance in poliomyelitis is so potent a cause of primary deformity and of a chain of secondary deformities and disabilities, that the only logical treatment must be an attempt to reduce the lack of balance by the redistribution of the available muscle power to the greatest functional advantage. Any success in the increase of thoraco-pelvic stability in a virtually flail trunk is bound to be a material gain. The operation, in suitable circumstances, is therefore indicated at any age and ought not to be deferred after reasonable hope of muscle recovery has ended.

SUMMARY

1. A dynamic muscle-tendon transposition is described for supplementing the power of weak lateral abdominal muscles, and the details of the operative technique are given.
2. A clinical assessment of the results in a series of twenty-four patients is given.
3. The indications for the operation in poliomyelitis are suggested.

We are deeply grateful to Dr Leo Mayer for his constructive and continuous help ever since his second visit to Israel in 1953 when he had the first opportunity to see the early results of these operations. His work on the role of abdominal muscle deficiencies in paralytic scoliosis and his ilio-costal fascial graft gave us the basis for the development of this operation.

We wish to express our thanks to Sir Harry Platt for reviewing a number of the patients during his visit to Israel, to Miss M. B. Kidd for taking charge of the post-operative rehabilitation, and to members of the staff of the Orthopaedic Department of Zrifin Hospital who gave us their unstinted help.

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THE RESULTS OF LUMBO-SACRAL FUSION FOR LOW BACK PAIN*

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The purposes of this research were, first, to estimate the reliability of lumbo-sacral fusion as performed at the Wingfield-Morris Orthopaedic Hospital over the past twenty years, and, secondly, to investigate the indications for the operation in the treatment of low back pain from non-infective structural lesions—namely spondylolisthesis, intervertebral disc degeneration and congenital anomalies. The series is not confined to fusion of the lumbo-sacral joint alone but includes all lumbar fusion operations for non-infective lesions in which the lumbo-sacral joint had been deliberately included.

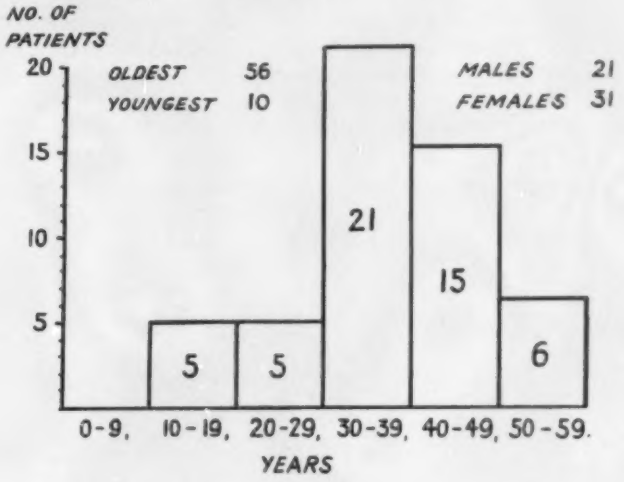

FIG. 1
Age at time of operation (fifty-two patients).

CLINICAL MATERIAL

The operations were carried out by seven different surgeons, but all used fundamentally the same principle, that of posterior fusion by onlay bone grafts without internal fixation but with subsequent immobilisation on a plaster bed.

The patients have been examined and assessed clinically, but estimation of bony fusion or otherwise has in each case been by radiographic study.

Records were available of sixty-one patients, of whom it was possible to review fifty-two with a total of fifty-five operations. In no case was the follow-up period less than one year. Of the fifty-two patients thirty-one were female and twenty-one male; the age distribution is shown in Figure 1.

Fusion operations were undertaken in seventeen cases of spondylolisthesis, twenty-eight cases of intervertebral disc degeneration, three of structural anomaly, and four of " non-specific low back pain " (Table I).

* Based upon a lecture delivered at the Nuffield Orthopaedic Centre, Oxford, on October 14, 1954, and upon a paper read before the Autumn Meeting of the British Orthopaedic Association, 1954.

For the purposes of this study the spondylolistheses were not graded, nor were the disc lesions subdivided into acute and chronic; the term " non-specific low back pain " was applied when the notes and radiographs did not give a clear diagnosis as to the cause of the symptom. Infective lesions were deliberately excluded from the review.

TABLE I
CLASSIFICATION OF DISEASE
(Fifty-two patients)

Spondylolisthesis	17
Disc degeneration	28
Structural anomalies	3
Non-specific low back pain	4

ASSESSMENT OF RESULTS

The results of operation have been assessed from two aspects—achievement of bony fusion and symptomatic relief. The criteria for the former are radiographic and are considered to be: 1) no discernible movement between spinous processes or posterior articulations of relevant vertebrae on comparison of lateral radiographs taken in maximal flexion and maximal extension of the spine (Figs. 2 and 3); and 2) progressive incorporation of the grafts with

FIG. 2
Successful fusion between L.4, L.5 and sacrum. No movement shown in flexion-extension radiographs.

spinous processes and laminae and " thickening " of the grafts as seen in serial antero-posterior radiographs (Figs. 4 and 5). The term " thickening " is used in preference to " hypertrophy," because when a bone graft has become vascularised and incorporated and is subjected to stress, its cancellous part becomes denser and develops trabeculation; it is thereby more obvious on a radiograph. It may not at that stage have actually hypertrophied in the true sense of the word.

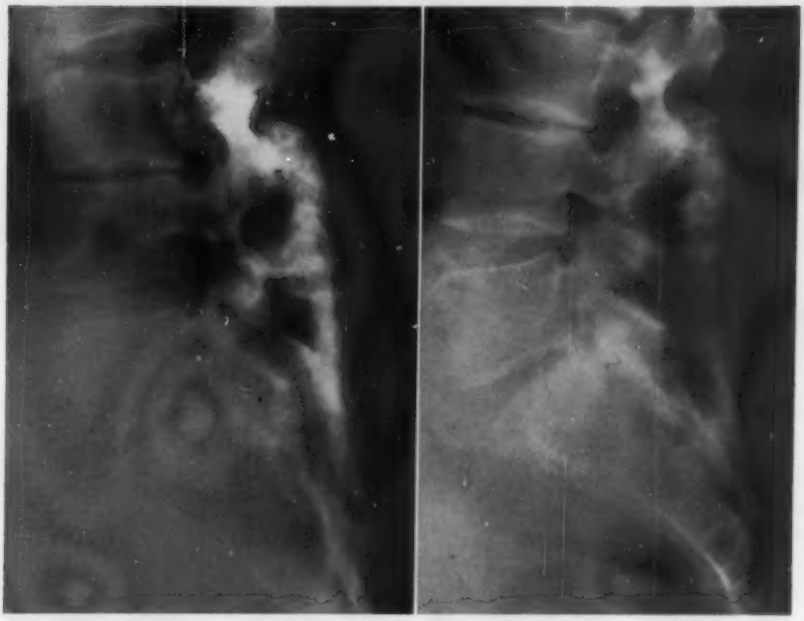

FIG. 3

Unsuccessful operation. Although there is no movement between L.3 and L.4 there is movement between the vertebrae below that level, and the graft lifts off the sacrum.

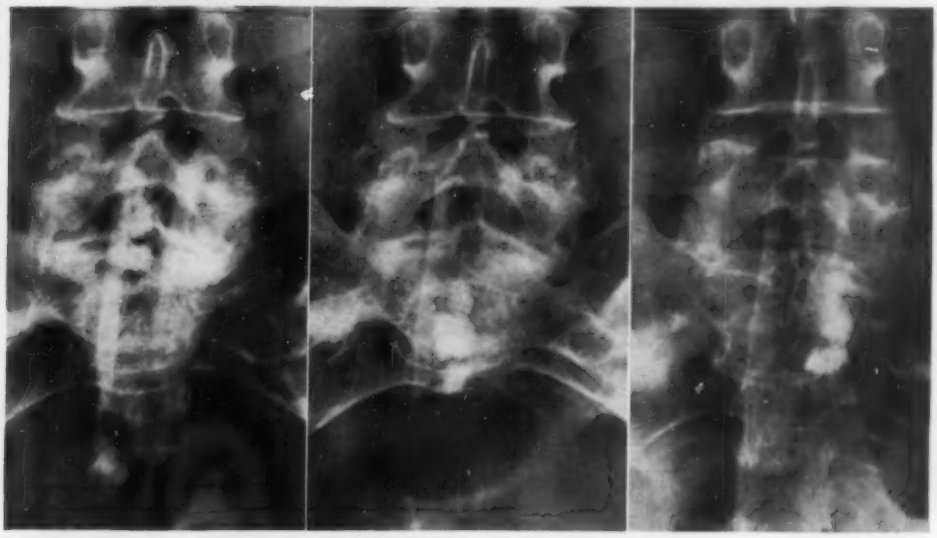

FIG. 4

Serial radiographs taken two months, ten months, and three and a half years after operation, showing progressive shaping and incorporation of the grafts. (They look less and less like a foreign body.)

RESULTS IN TERMS OF BONY FUSION

Application of the above criteria for bony fusion to each case gave the following figures. Sixty per cent of the operations were successful, 33 per cent failed, and 3·5 per cent were doubtful. The mortality from the operation was 3·5 per cent. These results are shown diagrammatically in Table II.

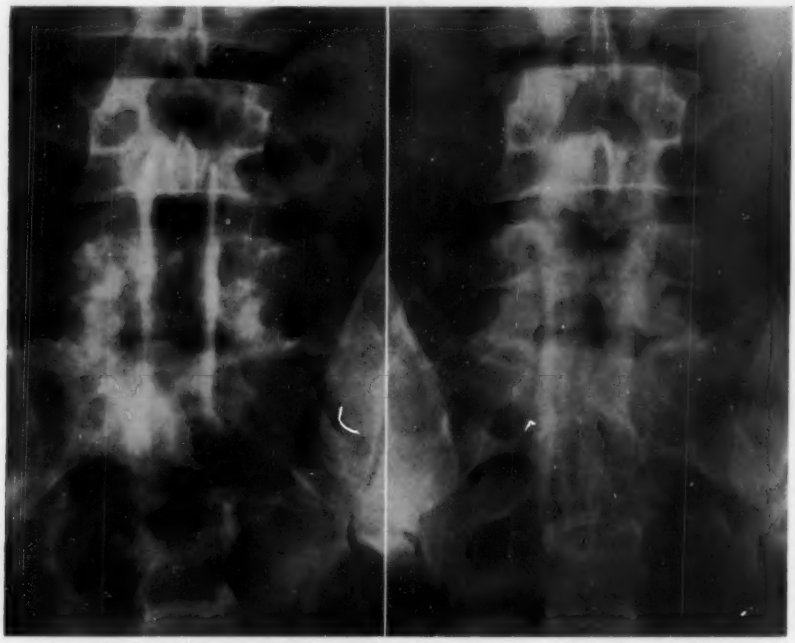

FIG. 5

Serial radiographs taken two months and two years after operation, showing " thickening " of the grafts.

Successful operations were those in which fusion was achieved throughout the extent of the spine involved by the lesion. Fusion of only part of that extent was classed as failure.

TABLE II

RESULTS OF OPERATION IN TERMS OF SUCCESSFUL FUSION
(Fifty-five operations)

Successful fusion	33
Doubtful fusion	2
Failed	18
Died	2

In the two doubtful cases it was not certain that the grafts were incorporated, although no movement was discernible between the relevant vertebrae in the flexion-extension radiographs.

Comparison of these results with other published series is made in Table III.

Detailed analysis—The results were correlated with the lesion for which operation was undertaken and the analysis is illustrated diagrammatically in Figure 6. The inference would

be in support of the general impression that it is easier to obtain fusion for disc lesions than for spondylolisthesis—in this series 68 per cent success as against 58 per cent.

TABLE III

COMPARISON OF RESULTS WITH THOSE IN OTHER PUBLISHED SERIES

Author	Number of operations	Technique	Flexion-extension radiographs	Success (*per cent*)
McBride 1949	135	Facet block	Yes	98
Straub 1949	80	Cortical + metal fixation	Yes	92
King 1948	Not stated	Cortical + screwing of facets	Some	90
Harris 1951	67	" Inlay " cortical	Not stated	84
Shaw and Taylor 1956	55	Onlay cortical	Yes	64

The results of fusion operations were correlated with the technique of bone grafting used, and this is illustrated in Figure 7. There were thirty-nine operations in which cortical tibial grafts were used. Of these twenty-four gave successful fusion, two were doubtful, and twelve

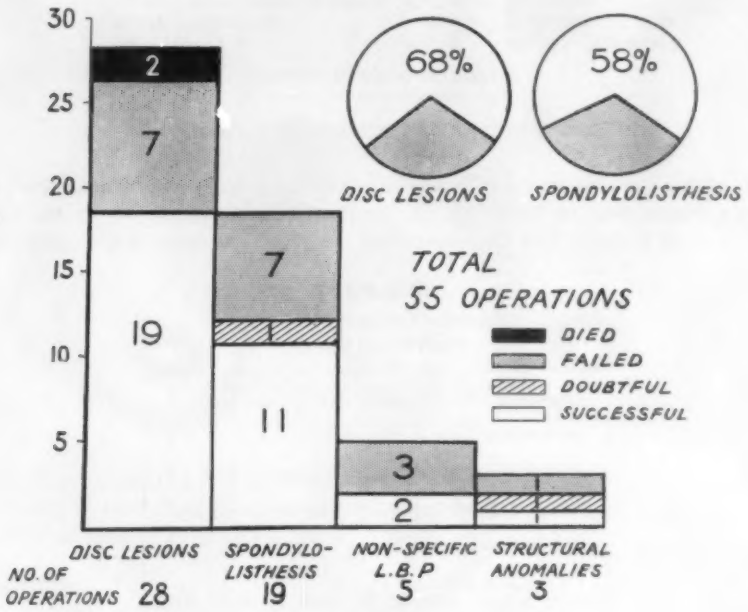

FIG. 6

Correlation of operative results with disease process.

failed. One patient died. Of nine " match-stick " grafts six gave successful fusion and three failed. Of five H-grafts two fused, two failed and one patient died. One Albee periosteal graft was successful, and one operation in which chips alone were used failed.

Throughout this series the bone used was always autogenous.

An attempt was made to break down the figures still further to show the results of each technique in relation to the disease process, but the numbers become small and of doubtful significance. However—for what they are worth—in spondylolisthesis there was a 64 per cent success with cortical grafting and 60 per cent with match-stick grafts.

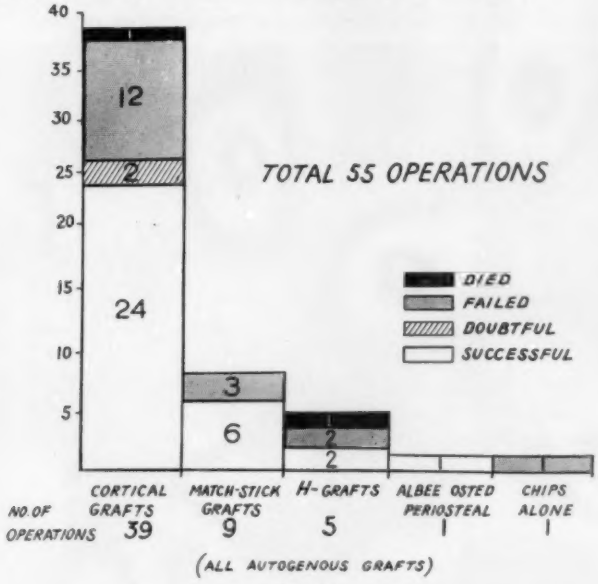

FIG. 7
Correlation of operative results with grafting technique.

Causes of failure—Possible causes of failure to obtain bony fusion were investigated, and the findings are summarised in Table IV. A significant factor seemed to be the period of immobilisation in a plaster bed after operation. Figure 8 illustrates this diagrammatically.

TABLE IV
PROBABLE CAUSES OF FAILURE
(Eighteen operations)

Immobilised for only eight weeks . .	7
Immobilised for only nine weeks . . .	2
Inadequately immobilised for unknown period	1
Sat up at six weeks in his plaster bed . .	1
Errors of technique	5
(*a*) insufficient bone	
(*b*) poor apposition	
Unknown	4

Among seventeen failed cases in which the period of immobilisation was known seven patients were immobilised for only eight weeks. On the other hand, of thirty-two patients with successful fusion only three were immobilised for so short a time. Ten to twelve weeks

seems to be the optimum period of immobilisation in cases in which internal fixation is not employed.

Errors of operative technique were blamed for failures in five cases—namely 1) the use of an inadequate quantity of bone graft, and 2) failure to obtain close apposition between the grafts and the recipient bed, a point on which Harris (1951) laid great stress (Figs. 9 and 10). In four cases there was no obvious cause for failure.

That failure becomes more likely the more vertebrae over which fusion is attempted is shown diagrammatically in Figure 11. In the cases shown below the line there was failure of fusion in some part of the graft. They include what we have called " relevant fusions "

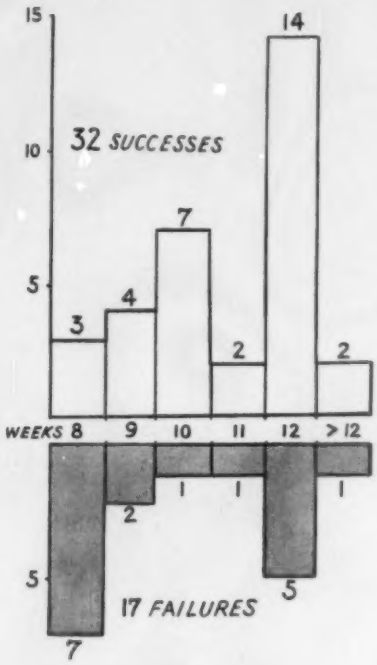

FIG. 8
Results in terms of successful fusion correlated with period of immobilisation in a plaster bed after operation.

(hatched). These are cases which in previous diagrams have been shown as operative successes because fusion was obtained over the level indicated by the pathology, although not at the upper end of an unnecessarily long graft.

RESULTS IN TERMS OF SYMPTOMATIC RELIEF

Each patient was specifically asked about symptomatic relief and about the nature of his work. Those who stated that they had no pain or only occasional slight pain, that they were pleased with the operation and were back at their former occupations, were regarded as satisfied patients. The reviewers' assessment of a satisfactory result required bony fusion and a satisfied patient with no untoward permanent complication.

Figure 12 compares the operative (bony fusion) results with symptomatic relief in disc lesions and in spondylolisthesis. All the patients who had successful fusion for spondylolisthesis

FIG. 9

An example of inadequate technique. Radiographs two months after operation show the grafts lying away from the spines and laminae, especially at their upper ends.

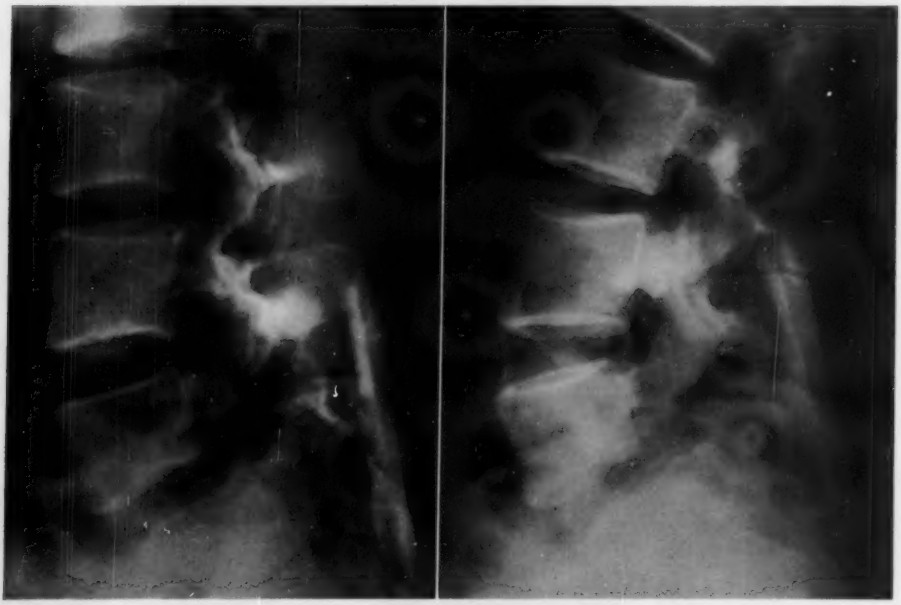

FIG. 10

Same case as Figure 9 a year after operation. Flexion-extension radiographs show obvious movement between the fourth and fifth lumbar vertebrae and the sacrum, and widening of the neural arch defect.

were satisfied, but we found two of these to be unsatisfactory from an objective point of view, one being the patient who developed spondylolysis above the graft and the other a patient with a persistent sinus following deep wound infection. Of the patients who were not satisfied

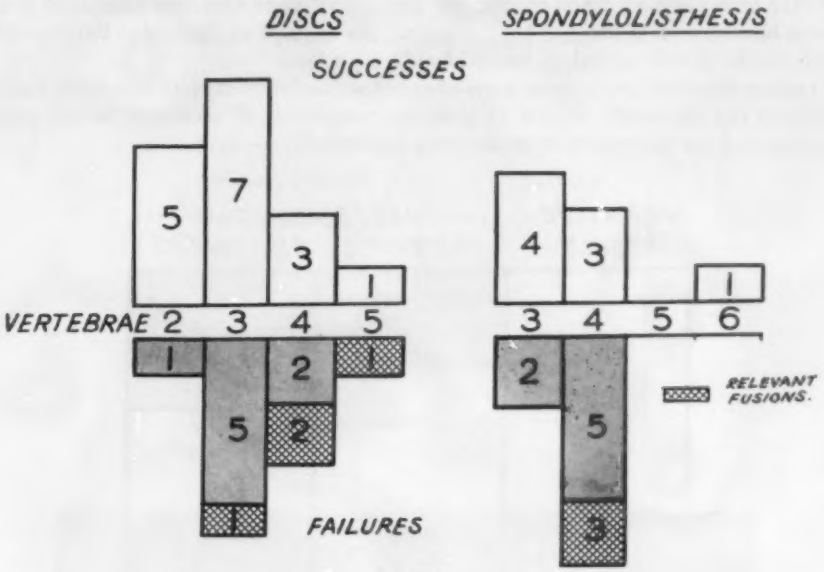

FIG. 11
Relationship of extent of fusion attempted with that obtained.

despite successful fusion for disc lesions, one developed lumbar osteoarthritis above the graft; one had very extensive lumbar osteoarthritis before operation; the radiographs of another showed eburnation of the lateral articulations extending above the grafted vertebrae; one

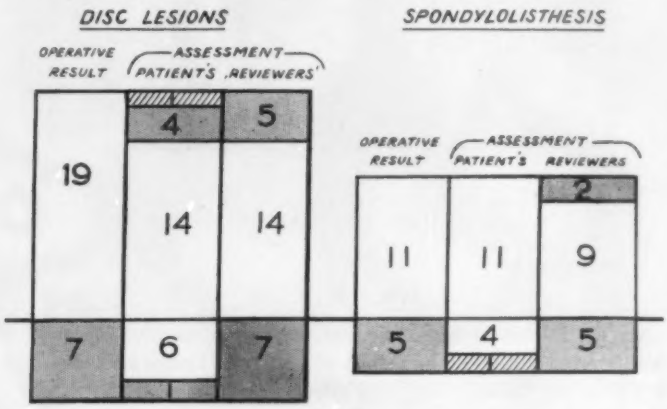

FIG. 12
Correlation of operative results and patients' and reviewers' assessments.

patient seems to be a hysteric and perhaps should not have been operated upon; a fifth patient is only doubtfully satisfied, because she still gets some low back pain, perhaps from a pseudarthrosis at the upper end of a graft which was unnecessarily long.

In the group of structural anomalies a patient with a transitional vertebra successfully fused to the sacrum still complained of pain, possibly because the cause of the trouble was between L.5 and the transitional vertebra.

In the group labelled " non-specific low back pain " there were two unsatisfied patients in whom lumbo-sacral fusion had been achieved: one of these we thought to have sacro-iliac arthritis but no definite pathology was evident in the other.

It seems therefore that in most cases of symptomatic failure despite successful fusion an explanation can be found. Figure 13 gives the comparison of successful fusion, patients' assessment and our assessment in all the cases together.

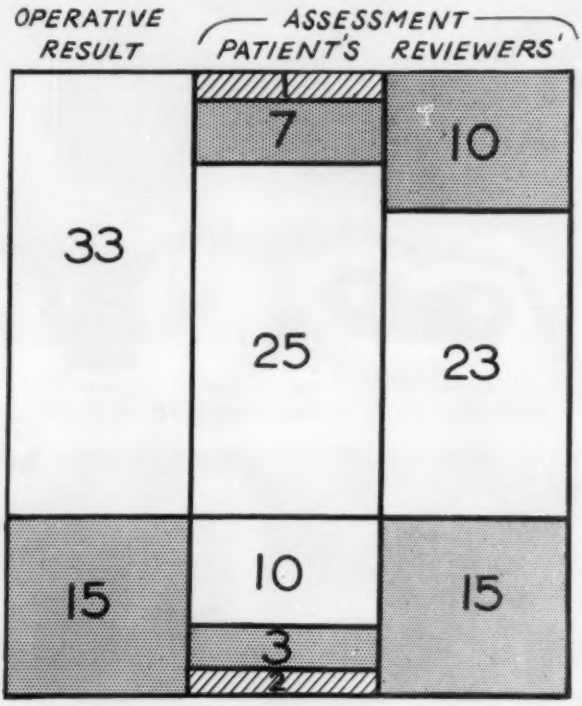

FIG. 13
Combined diagram showing results in terms of successful fusion, the patients' assessment and the reviewers' assessment.

COMPLICATIONS

The list of complications in this operation seems formidable (Table V). Infection in no case caused failure of fusion. The incidence of deep vein thrombosis was high. Whenever its site was noted in the records it always affected the donor leg. Perhaps anticoagulant therapy might reduce the peril of this complication provided it is diagnosed early.

An interesting complication was the post-operative development of spondylolysis in the uppermost vertebra after an otherwise successful fusion performed for spondylolisthesis of the fifth lumbar vertebra in a child of ten (Figs. 14 to 17).

The fate of nine patients who at some time were considered to be " functional," but who were eventually operated upon, was investigated. Of five whose spines were successfully

fused, four were cured of their symptoms; and two in whom fusion failed were also cured symptomatically.

TABLE V

INCIDENCE OF COMPLICATIONS

Complications	Cases
Wound infection	3 (5·5 per cent)
Deep vein thrombosis . . .	11 (20 per cent)
Pulmonary embolism . . .	5 (2 fatal)
Painful donor tibia . . .	6
Post-operative ileus . . .	1
Renal colic	1
Lateral popliteal palsy in donor leg	1
Stiff shoulders after immobilisation in plaster bed	1
Spondylolysis above the graft .	1

FIG. 14

Pre-operative radiographs of a child of ten showing spondylolisthesis at the lumbo-sacral level. There is a defect in the fifth lumbar neural arch. There is no defect in the neural arches above this level.

SUMMARY AND CONCLUSIONS

1. In this series of posterior onlay grafting with fresh autogenous bone and without internal fixation, in the treatment of non-infective structural lesions in the lumbo-sacral area, 71 per

FIG. 15

FIG. 16

Figure 15—One year after operation the graft was incorporated with the spines of L.3, L.4, L.5 and the sacrum.
Figure 16—Three years after operation there is a defect in the neural arch of L.3.

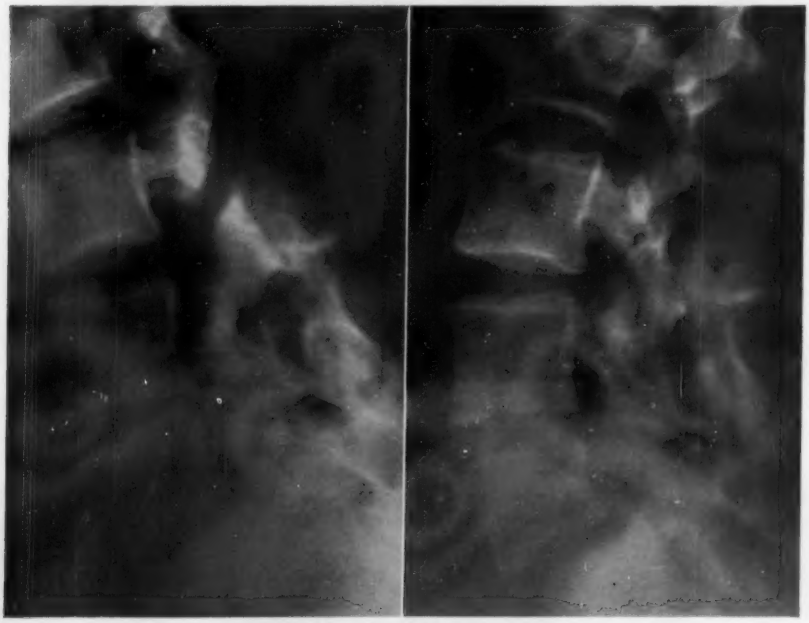

FIG. 17

Four years after operation. Flexion-extension radiographs show solid fusion of the graft and opening of the neural arch defect which has developed above the level of the graft, presumably the result of abnormal stress.

cent of the patients were relieved of their symptoms, but bony fusion was obtained in only 60 per cent.

2. It is probable that with this technique twelve weeks' immobilisation in a plaster bed is required.

3. Some failures are ascribed to the use of an insufficient quantity of bone or to poor apposition of the graft to its bed.

4. It is evident that the more vertebrae one attempts to fuse the more difficult it is to succeed. When the diseased area is successfully fused but an unnecessarily long graft has been used, a pseudarthrosis above the level of the pre-operative pathology may be the cause of persisting backache. For these reasons we believe that one should not attempt to graft more vertebrae than is necessary to stabilise the local lesion.

5. The complication rate, particularly from deep vein thrombosis, was high. This major complication could perhaps be overcome by using banked bone.

6. The indications for the operation are assessed as follows. It should be done for low back pain only when there is a definite diagnosis and a limited extent of structural pathology; one can then expect excellent results when successful fusion is achieved and also an appreciably high proportion of satisfied patients even when bony fusion has not been obtained, presumably because there is a fibrous union strong enough to stabilise the affected spine.

It is inadvisable to undertake lumbar-lumbo-sacral fusion for intervertebral disc degeneration when there are more than three adjacent vertebrae involved, and in any case operation should be confined to the indicated extent.

We wish to thank the surgical staff of the Nuffield Orthopaedic Centre for permission to review their cases. We are particularly grateful to Professor J. Trueta for valuable criticism and advice, and to Dr F. H. Kemp for assistance with radiographic interpretation. We are appreciative of the work and time freely given by the staffs of the radiological and photographic departments, and by the clinical artist.

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PSEUDOCOXALGIA*

A Study of Late Results in the Adult

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The aim of this paper is to determine the late results of idiopathic pseudocoxalgia (Legg-Calvé-Perthes disease) in adult life. It is hoped to obtain some idea of the efficiency of treatment and of the factors that influence prognosis.

In the enormous literature of this condition, only three papers can be found which contain reports of cases which have been observed for long periods. Legg (1927) reviewed forty cases for ten or more years. He divided these cases into two types, the " cap " and the " mushroom." He stated that: " Ultimately the cases of both types will never be incapacitated. In the majority they will tire after long standing and walking, or after movements that require extreme abduction. More than half the cases will probably show a persistent limp." Unfortunately he gave neither details nor case histories. Mindell and Sherman (1951) reviewed seventy-eight hips in seventy-two patients, but only twenty-two hips were observed for sixteen years or more. They stated that most patients had some residual effects, but even those with the worst results were not severely handicapped. They grouped the immediate and late results together, and it is therefore difficult to compare their results with those presented in this paper. On the other hand, the third paper, that of Branciforti and Montina (1954) (a study of twelve hips followed up for an average of twenty-four years) concluded that the fate of these hips is a severe one " leading us to erase from our minds all that we have ever read about osteochondritis of the hip."

A REVIEW OF FIFTY AFFECTED HIPS

The material for this study is based on fifty hips observed for a period between eleven and thirty years (average period of follow-up being seventeen years). Most of the patients studied had been treated at Biddulph Grange Orthopaedic Hospital, a few at the Robert Jones and Agnes Hunt Orthopaedic Hospital, the Ethel Hedley Hospital, the Royal Hospital for Sick Children, Edinburgh, and the Princess Margaret Rose Hospital. In all cases the diagnosis was definite, the radiographic findings in childhood and method of treatment known, and all were seen and radiographed in adult life. Every case that could be obtained has been included and no selection employed. Thirty-eight of the hips had been treated by fixation on frames; three had been immobilised in hip spica plasters. I have not attempted to differentiate between the result of these methods. Nine received no treatment during the active phase of the disease, though a few of these received some treatment too late, when the femoral head was already partly reformed. These are classified together as " untreated " cases.

ASSESSMENT OF RESULTS IN ADULTS

Many patients had no complaints and their hips showed full movement, despite varying degrees of deformity. These cases were difficult to classify, and therefore a point system was employed, based on that used by Muller and Seddon (1953) in assessing cases of congenital dislocation of the hip. Every patient was given a maximum of five points for each of pain, activity, movement, and radiographic appearances, and the points were awarded as shown.

* Paper read in abstract at the joint meeting of the French and British Orthopaedic Associations in Paris, May 1955.

Pain (P)

1. Severe.
2. Severe on movement; little at rest.
3. Moderate; limits activity.
4. Slight ache after prolonged standing; does not limit activity.
5. None.

Activity (A)

1. Walks short distances only, with difficulty.
2. Walks half a mile.
3. Walks two miles.
4. Walks long distances, but cannot do heavy work or play games.
5. Normal.

Movement (M)

1. Little or none.
2. Less than 50 per cent; fixed deformity.
3. More than 50 per cent; no fixed deformity.
4. Slight limitation.
5. Full.

Radiographic appearance (X)

1. Gross evidence of osteoarthritis, with severe loss of " joint-space."
2. Completely distorted head, only partly contained; no neck; occasionally great trochanter above level of the head; "joint-space" good.
3. Very flattened head, incompletely contained; very short neck; occasionally early sclerosis of the acetabulum.
4. Slightly flattened head; fully contained; slightly short neck.
5. Normal or almost normal appearance.

A normal joint would thus be described as P5, A5, M5, X5, scoring a total of 20 points. Each joint examined was allotted marks in this way, and hence they were finally classified into four groups:

Good	18 points or over
Fair	17 to 15 points
Poor	14 to 11 points
Very poor	10 points or less

This classification is demanding. It expects a hip to obtain 18 points out of 20 to be classified as good. But all the patients were less than forty years old, and it was felt that those with appreciably deformed hips could not be placed in the " good " class, even though they had no pain and normal activity.

RESULTS

The general results are illustrated in Table I.

Two general conclusions are seen from examination of these results. First, in cases of pseudocoxalgia followed into adult life, rather more than one-third were good, the same number were fair, and about one-quarter were poor. Second, though three-quarters had no pain and normal activity, only two-fifths had good hips radiologically.

Radiological features in the adult—Legg divided his cases into two types, the " cap " and the " mushroom." In the former type there was simple flattening of the head; in the latter there was spreading out as well. In this series about half the total (twenty-six) showed appreciably deformed hips (X3 or less). The majority were of the mushroom type, and only six were cap-shaped. A characteristic pattern of deformation of the femoral head and neck was found based on the degree of flattening of the head and of shortening of the neck, and this is detailed in the description of the points classification. Noteworthy features, which so far as I am aware have not been detailed previously, are the high incidence of gross neck shortening (see later)

and the frequent early occurrence of sclerosis of the upper lateral aspect of the acetabulum. The cap types were characterised by an early sclerotic appearance of the upper aspect of the head, and marked sclerosis of the adjacent surface of the acetabulum. The numbers observed are not sufficient to merit discussion of the prognostic significance of the two types. In adult hip surgery the diagnosis of " old healed Perthes' disease " is frequently encountered, but this is usually presumed rather than proved. Examples of some of these stages of deformation are shown in Figures 1 to 6.

TABLE I

A Review of Fifty Hips in Forty-six Patients

Ages of patients:	16–40 years (average 25)	
Length of follow-up:	11–30 years (average 17)	
Good hips	(18–20 points)	19
Fair hips	(15–17 points)	19
Poor hips	(11–14 points)	7
Very poor hips	(under 11 points)	5
Details:		
Pain	None or slight aches	43
Activity	Normal	38
Movement	Full or terminal limitation	31
Radiographs	Normal or slightly flattened	20

THE VALUE OF TREATMENT

A discussion of the value of different types of treatment is outside the scope of this paper, for in this series (with few exceptions) only one method was employed, namely frame fixation. A comparison of the results of treated and untreated cases is shown in Table II. Only one out of nine untreated cases gave a good result. This series, though small, suggests that treatment is worth while.

TABLE II

The Value of Treatment (Fifty Hips)

Result	Treated	Untreated
Good . . .	18	1
Fair . . .	15	4
Poor and very poor	8	4
	41	9

COMPLICATIONS AND SEQUELAE

This series of cases was free from general complications of prolonged decubitus, such as renal calculi. The following were among the local complications that developed:

Osteoarthritis—The term osteoarthritis is used to describe anatomically degenerate hips (X3 or less) with limitation of movement.

Osteoarthritis may follow pseudocoxalgia in two quite different circumstances. In the adult it may develop years after treatment, being apparently due to incongruity between the articular surfaces of the femoral head and the acetabulum. Both adjacent articular surfaces become flattened and irregular, inviting degenerative change. In this series there were twenty-five hips (one half) with some degree of osteoarthritis. In the majority this was mild and a radiological finding in a joint that was painless. There was gross osteoarthritis with

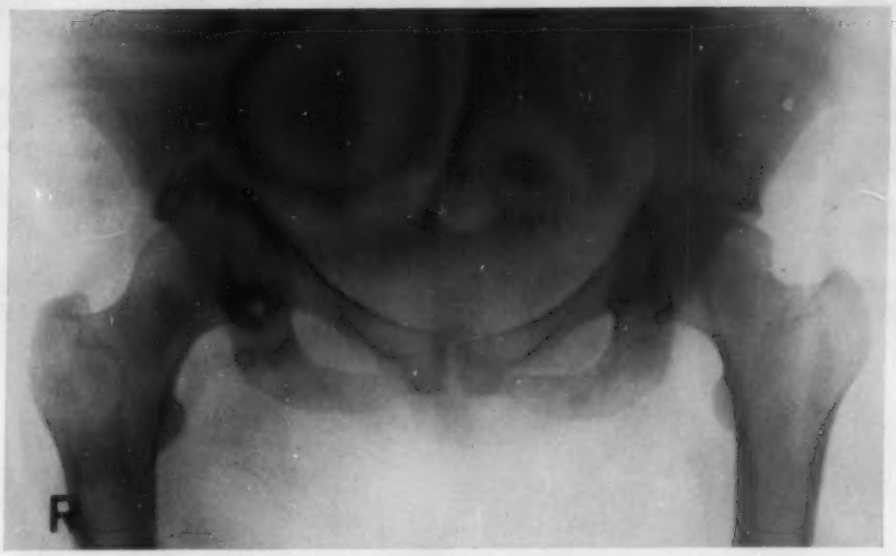

FIG. 1

An almost normal left hip in a woman of twenty-eight after pseudocoxalgia when aged seven. Note the slight elevation of the lesser trochanter (graded X5).

FIG. 2

A left hip showing a slightly short neck and a slightly flattened but fully contained head (graded X4). Pseudocoxalgia eighteen years earlier at the age of eight.

loss of joint space, subluxation and pain in five (Fig. 5). The earliest and most common radiological change was a sclerosis of the upper lateral aspect of the acetabulum (Figs. 3 and 4).

In the child marked deformation of the femoral head may be present at the end of treatment or even before treatment starts. In a small proportion of cases in which the femoral head is deformed, movement is not recovered when treatment ceases and gross degenerative changes develop early in adolescence. This type is rare, and I can find no reference to it in the English literature, though it does not appear to be unknown (Korvin 1954). In this series there were three such cases. In all three there was a rapid development of severe degenerative changes in the hip (illustrated in Figures 7 and 8) requiring operative treatment in adolescence. The radiographic changes resembled those of slipped upper femoral epiphysis with early ischaemic necrosis of the femoral head.

Failure of growth of the femoral neck—After the evolution of the disease was apparently complete there was sometimes a retardation of growth of the femoral neck. This occurred

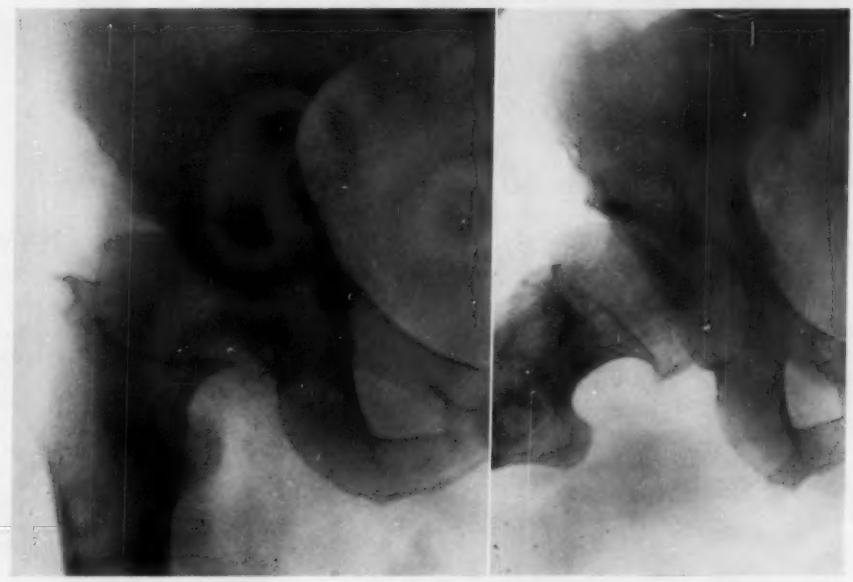

FIG. 3

A right hip with a very flattened head, incompletely contained, and a very shortened neck (X3). Note the early sclerosis of the acetabulum in the lateral view. Pseudocoxalgia fifteen years earlier, at the age of twelve.

in at least ten cases in this series. It was present in some of the poor results and led to severe deformity. Failure of femoral neck growth receives little mention in the literature. Gall and Bennett (1942) found evidence in one post-mortem specimen that " bone growth was markedly retarded throughout the upper femoral epiphysis," and Mindell and Sherman (1951) stated that "evidence of severe femoral-neck disturbance with damage to the epiphysial plate is followed by deformity and a poor result. Often only a portion of the epiphysial cartilage is damaged and the result is asymmetrical growth-retardation which may not become evident for some time."

Precise assessment of growth failure in the neck of the femur is impossible. In no case in the present series was premature fusion at the epiphysial line proved radiologically, but in at least the ten cases mentioned the neck of the femur failed to grow to the expected adult length. This could be demonstrated most clearly when a well developed femoral neck was seen to be present in childhood, though there was no neck at all in adult life (Figs. 9 and 10).

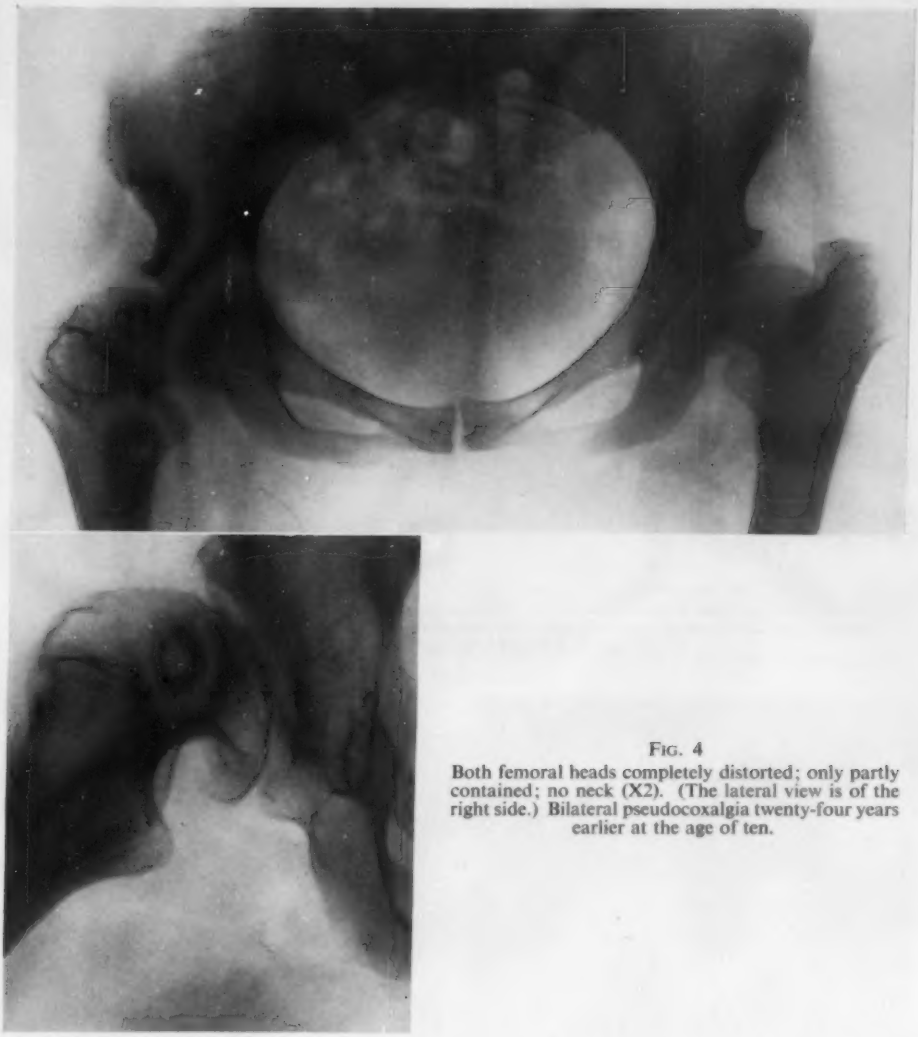

FIG. 4
Both femoral heads completely distorted; only partly contained; no neck (X2). (The lateral view is of the right side.) Bilateral pseudocoxalgia twenty-four years earlier at the age of ten.

Osteochondritis dissecans—The etiology of osteochondritis dissecans of the hip is obscure. King and Richards (1940) stated that it was due to an aseptic necrosis of a localised segment of subchondral bone. Magnin (1931) had previously stated that no relationship between this condition and pseudocoxalgia existed. He regarded the evolution and treatment of the two affections as entirely dissimilar. In this series there were two cases of osteochondritis dissecans following pseudocoxalgia.

The first was in a boy aged ten, admitted to hospital in 1936 with left pseudocoxalgia. He had previously had twelve months' immobilisation in a hip spica at a local hospital, and then had been allowed to walk freely for a further nine months. Radiographs in 1936 (Fig. 11) showed a healing pseudocoxalgia, with the head slightly flattened, and a localised area of dense sclerosis in the centre of the head towards the supero-lateral aspect. He was treated by a further seven months in a hip spica in hospital. Follow-up radiographs in 1941 and even in

FIG. 5

FIG. 6

Figure 5—A right hip showing gross osteoarthritis (X1). Pseudocoxalgia twenty-one years earlier at the age of thirteen. Figure 6—A left hip showing the less common " cap " type of deformity with flattening of the femoral head but very little spreading out. Note the sclerosis of the head (X3). Pseudocoxalgia fifteen years earlier at the age of five.

FIG. 7

FIG. 8

Figure 7—A right hip showing healing pseudocoxalgia in a child aged eleven at the end of twenty-one months' immobilisation in a hip spica. Figure 8—Five years later, the hip already shows some loss of joint space with subluxation. There was gross restriction of all movements and an adduction and lateral rotation deformity. The hip was painful. Movement had never recovered well after immobilisation.

FIG. 9

Radiograph of a child aged eight immediately at the end of eleven months' frame fixation. Note the broad, slightly shortened neck.

FIG. 10

The same patient seventeen years later, with no femoral neck and the greater trochanter above the level of the head.

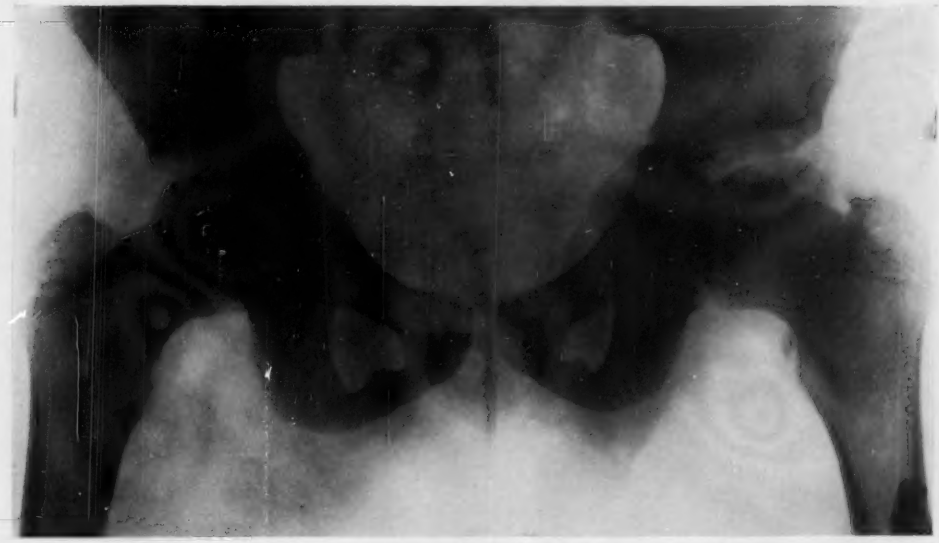

FIG. 11

Radiograph showing a healing left pseudocoxalgia in a boy of ten, with the head slightly flattened, and a localised area of dense sclerosis in the centre of the head towards its supero-lateral aspect.

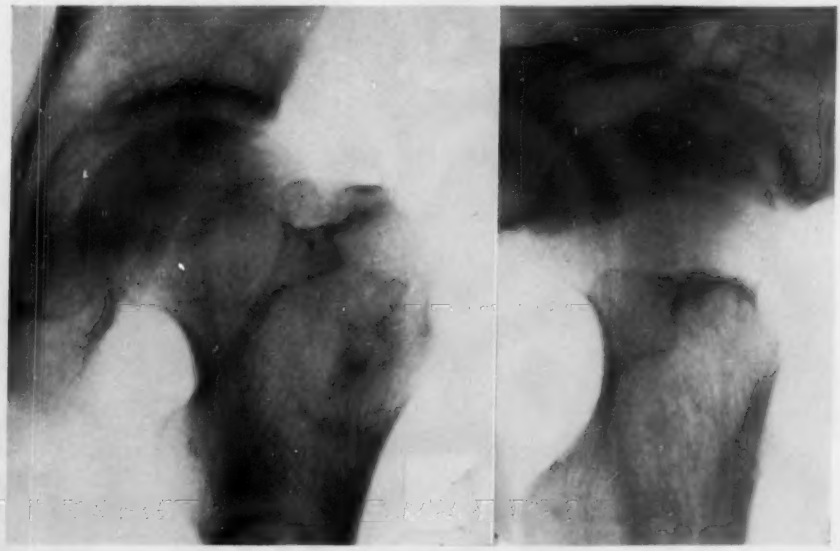

FIG. 12

Antero-posterior and lateral radiographs eighteen years later showing a clearly outlined area of osteochondritis dissecans.

FIG. 13
Radiograph when aged seven, showing a flattened irregular left femoral head with a dense area of sclerosis in its centre.

FIG. 14
Radiographs of the same patient twenty years later showing an area of osteochondritis dissecans.

1954 showed a clearly outlined area of osteochondritis dissecans (Fig. 12). Then, at the age of twenty-eight, he was working as a carpenter.* He suffers an occasional slight ache in the hip, but no interference with work or activity. There was slight wasting of the left thigh, but no limp. There was a full range of painless movement in both hips. No loose body has as yet separated.

The second patient, a boy of seven, was admitted to hospital in 1933 with left pseudocoxalgia. Radiographs (Fig. 13) showed a markedly flattened, irregular head with a dense area of sclerosis in its centre. He was treated by immobilisation on a frame for nine months. When seen recently he was aged twenty-six and was doing work involving long hours and heavy lifting. There were occasional cramp-like sensations in the left hip, but these caused him no disability. He had no limp, and movements were full except for terminal limitation of abduction. Radiographs (Fig. 14) showed a sclerotic " cap " type of head and in the lateral view a clearly outlined area of osteochondritis dissecans. There was no loose body formation.

It seems probable that a localised segment of the femoral epiphysis lost its blood supply for ever in the active phase of the disease. This occurrence of osteochondritis dissecans following pseudocoxalgia is evidence in support of the avascular origin of both conditions.

FACTORS INFLUENCING THE OUTCOME OF PSEUDOCOXALGIA

There is general agreement that the future of a hip afflicted with avascular necrosis of the capital femoral epiphysis will depend upon the amount of deformation which has occurred in that epiphysis by the time the disease is recognised. Perhaps the most important single factor in the outcome of the disease is its natural history in the particular patient afflicted. There appears to be a wide variation between abortive cases in which there is no severe flattening and fragmentation, and severe cases in which the restoration of the shape of the epiphysis appears to take several years. This disease follows no time-table. In most cases its evolution takes about two years, but in many this time may be considerably exceeded.

Apart from such obvious considerations, the future of the hip may depend upon two other factors, the age at the onset of the disease and the effect of the disease upon the growth of the femoral neck. The former was investigated by Eyre-Brook (1936) and by Møller (1926).

The age at the onset of the disease—The effect of age upon the outcome of the disease is illustrated in Table III and Figure 15.

It can be seen that in the ten hips in which the disease developed in children aged five or less, all had good results. Conversely, in the nine hips in which the disease developed in children aged ten or more, none had a good result. The younger the child, the better the prognosis.

Failure of femoral neck growth—This has already been discussed. It was quite unpredictable and I was unable to confirm the statement of Mindell and Sherman (1951) that it was more likely to occur when there was evidence of severe femoral neck disturbance. Failure of femoral neck growth is an important cause of the high percentage of poor radiological appearances in the adult.

These factors may be clarified by examining the common features of each class of end-result.

In the hips classified as good, the condition had often developed in a child under seven years of age; fifteen out of nineteen had only slight flattening of the upper femoral nucleus when treatment was commenced; in none was there fragmentation. The cycle was often of short duration, the average period of immobilisation only thirteen months.

In adult life these nineteen patients had no symptoms and good radiological appearances. An example is shown in Figures 16 to 19.

* I am indebted to Mr E. F. West for his kindness in reporting to me the present state of this patient, who has emigrated to Australia.

In the "fair" group the typical picture was that of a more severe disease in an older child. One half of these hips were grossly fragmented at the beginning of treatment. The average duration of immobilisation was longer—sixteen months—and several epiphyses were

TABLE III

EFFECT OF AGE UPON PROGNOSIS (FIFTY HIPS)

Age at onset of disease (*years*)	Results		
	Good	Fair	Poor and very poor
3	1	—	—
4	4	—	—
5	5	—	—
6	3	2	2
7	2	7	2
8	3	2	2
9	1	3	2
10	—	2	—
11	—	1	—
12	—	2	—
13	—	—	4

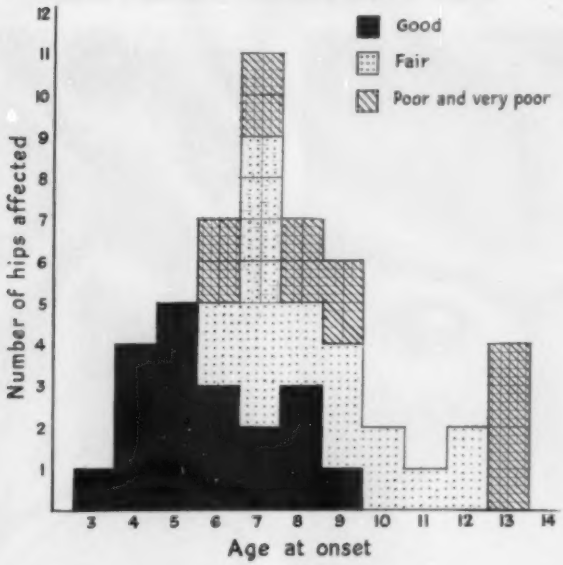

FIG. 15

The effect of age upon the prognosis.

not fully reformed at the end of treatment. In the adult these nineteen patients had no symptoms but all these hips had poor radiological appearances (Figs. 20 to 23).

The common feature of the twelve poor and very poor results was that they were all

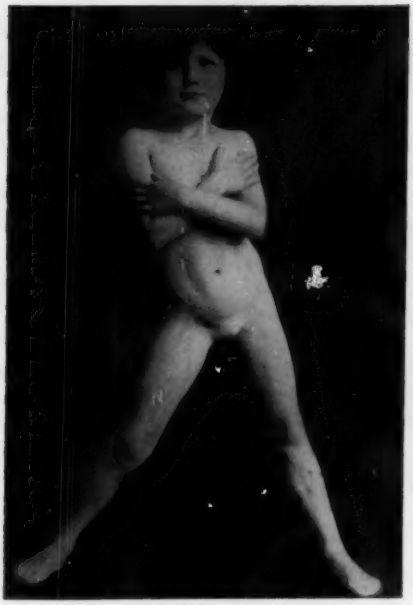

FIG. 16

FIG. 17

Figure 16—Photograph on admission to hospital at the age of seven. Note the well marked limitation of abduction of the left hip. Figure 17—Radiograph at the same time showing a typical pseudocoxalgia with only mild flattening of the head and no fragmentation.

FIG. 18

FIG. 19

Figure 18—Same patient. Radiographs after fifteen months' frame fixation. The femoral epiphysis has reformed fully with only mild flattening. Figure 19—Radiographs at the age of twenty-six showing an almost normal left hip.

FIG. 20

FIG. 21

Figure 20—Photograph on admission when aged nine. Pseudocoxalgia of left hip. Figure 21—Radiograph at the same time showing gross flattening and fragmentation of the left femoral epiphysis.

FIG. 22

FIG. 23

Figure 22—Same patient. Radiograph after twenty-two months' frame fixation, showing a fairly well reformed but considerably broadened femoral head and metaphysis. Figure 23—Radiograph at the age of twenty-five showing a very flattened head, incompletely contained, and a very shortened neck. There was normal activity and no limp, but terminal limitation of all movements.

poor from childhood. Three developed degenerative changes immediately after treatment, and these led rapidly to stiff, painful hips (Figs. 7 and 8). Seven had gross flattening of the upper femoral nucleus when first seen, and four had had no treatment at all. Three showed failure of femoral neck growth (Figs. 9 and 10). In the adult this was the only group which presented symptoms.

SUMMARY AND CONCLUSIONS

A review of fifty cases of idiopathic pseudocoxalgia (Legg-Calvé-Perthes disease) followed into adult life for periods of eleven to thirty years (average seventeen years) after diagnosis shows:

1. In the whole series rather more than one-third of the patients developed hips which were normal or nearly normal.
2. An equal number had hips which could only have been considered " fair."
3. About one quarter had hips which gave pain and which showed marked loss of movement and gross degenerative changes radiologically.

Judged from the point of view of symptoms, the results were better than the foregoing would suggest. Three-quarters of the patients were fully active and free from pain but only two-fifths had hips which were radiologically good. It is possible that such apparently good results are unlikely to be permanent, and I hope, therefore, to continue this follow-up for another ten or fifteen years. It can, however, be concluded at this stage that an immediate good result is likely to be maintained at least until the age of twenty-five years, even though half of such patients will have radiologically abnormal hips.

There is a characteristic pattern of deformation of the femoral head and neck in the adult resulting from this condition in childhood, based on the degree of flattening of the head and shortening of the neck.

The end-results are better in adequately treated cases.

Two cases are reported in which osteochondritis dissecans developed as a late complication.

My sincere thanks are due to the members of the consultant staffs of the hospitals in which the patients were treated, for permission to study their cases and their records. I am also very grateful to Sir Harry Platt for his constant encouragement, to innumerable colleagues who helped me in tracing patients, and to Professor Sir Walter Mercer, Mr D. Ll. Griffiths, and Mr D. L. Savill for their help and criticism in the preparation of this paper.

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THE ANTERIOR TIBIAL SYNDROME

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Acute ischaemia of the anterior tibial muscles with consequent replacement fibrosis or, in severer cases, necrosis of muscle is a well recognised entity. In 1942 Child collected fourteen cases from the literature and added one of his own. Since that time a further twenty-two cases have been reported (Sirbu, Murphy and White 1944, Horn 1945, Phalen 1948, Hughes 1948, Pearson, Adams and Denny-Brown 1948, Carter, Richards and Zachary 1949). Ischaemic necrosis secondary to severe injury is the most common type of this condition, which may thus complicate fractures involving the bones of the lower leg. Other cases have followed exercise. A more chronic form of the condition with symptoms persisting for a long time has not been clearly defined. Hughes (1948) suggested in relation to acute ischaemic necrosis that the syndrome was probably fairly common, but that many cases were wrongly diagnosed or even overlooked. Such an observation seems likely to be even more accurate in explaining the absence so far of any description in the literature of a chronic or persistent form of the condition. That such does exist is suggested by the following case.

CASE REPORT

A professional footballer, aged twenty-four years, was admitted to the Aberdeen Royal Infirmary with a complaint of pain in the front of both lower legs occurring on exercise. This had been present for two years. The onset was gradual, and it had coincided with his

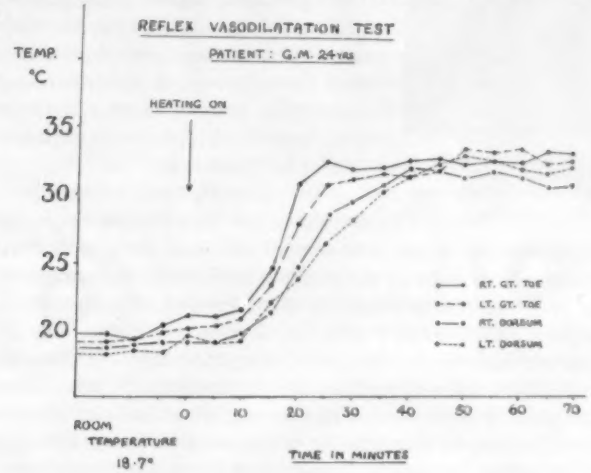

FIG. 1

Reflex vasodilation test. There is no significant delay in heating of the left great toe or dorsum of foot.

becoming a full-time professional footballer and undertaking more intensive training. Gradually the pain had become more annoying because of its increased frequency and severity. It had begun first in the left leg, radiating from the lateral aspect down the shin towards the ankle. He described the pain as a " tightness " rather than a cramp, increasing

in severity with exercise and always forcing him to rest. The pain in the right leg was exactly similar, although not quite so severe. During the past six months the severity of the pain had forced him to rest after ten minutes of active training or playing football. With the pain he had also noticed numbness over the front of the ankles, a complaint that he tried unsuccessfully to treat by immersing his feet in hot water. There was no pain at rest or after walking or moderate exercise. There was no history of claudication in the calf or foot, or of pallor on exercise, or of injury or phlebitis. He was right-footed. Part of his regular routine training was to develop the left foot. On examination the patient's highly developed musculature, particularly about the legs, suggested "over-training." There was no evidence of ischaemia at rest and no change in the skin or nails of the feet. There were two small muscle herniae over the upper third of the anterior tibial muscles on each side. These gaps in the fascia were about equal in size, oval in shape, and admitted the tip of the fore-finger. Ankle movements were full and powerful, and no peritendinitis was noted. There was no sensory loss. All the distal pulses were present, equal and easily felt. Examined after severe exercise, the pulses were still palpable. However, although there was no localised exercise pallor, the left foot over the dorsum felt colder than the right, and skin temperature recordings showed a fall of 2 to 4 degrees as compared with the right dorsum.

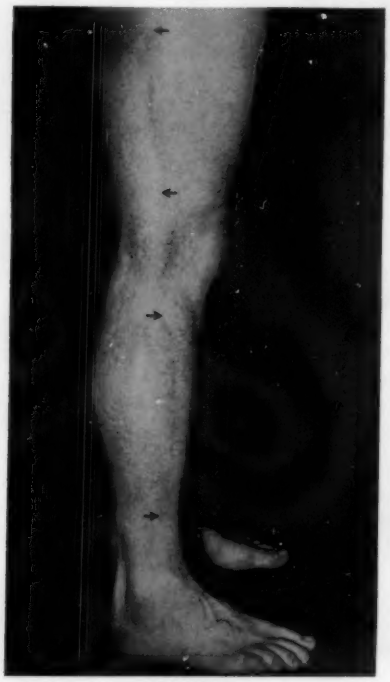

FIG. 2
Right lower limb showing the scars on the thigh and leg. The extremities of the scars are indicated by arrows.

The blood Wassermann and Kahn tests, full blood examination, radiographs of the chest and legs, and electrocardiography showed no abnormality. Skin temperature recordings on the feet after heating the trunk showed full vasodilation of the skin vessels (Fig. 1). Arteriography was not considered justifiable.

The diagnosis of exercise ischaemia of the anterior tibial muscles was made. It was decided to try the effect of producing slight inversion of the foot along with dorsiflexion of the ankle. Accordingly, the front studs of the patient's football boots were placed on transverse bars, and a rubber pad was placed along the medial aspect of each sole. Tried for four weeks, this had no effect on the exercise pain.

Since the patient did not wish to change his occupation, operation was advised.

Operation—The fascia over the left anterior tibial compartment was incised, the incision including the fascial gaps. Repair was effected by a graft of fascia lata, measuring 8 inches by 2 inches. Biopsy of the anterior tibial muscle, which looked normal, showed no abnormality. The muscle tissue showed no ischaemic features and there was no evidence of fibrosis or organisation. After six weeks, during which it was clear that the patient's symptoms in the left leg had improved greatly, a similar operation was undertaken on the right side. Again the muscle tissue examined was normal.

Progress—Convalescence was uneventful. The patient has been followed up for four years since the operations. At no time has there been any recurrence of exercise pain. Although the muscles of the anterior tibial compartment have remained bulky, there was no evidence of muscle herniae (Fig. 2). The patient is still playing professional football, and his career

has maintained its early promise as he is now the centre-forward of a leading First Division club.

DISCUSSION

There appears to be little doubt about the diagnosis in this case. The nature of the anterior tibial pain suggested exercise ischaemia because it was constantly related to excessive exercise. The presence of the small muscle herniae indicated the possibility of excessive pressure in the anterior tibial compartment, presumably during this exercise, and it is important that the patient had bulky, highly developed muscles. The success of the operations gives further confirmation of the diagnosis. It is probable that the onset of ischaemic pain can be related to the increased training programme, although it is doubtful whether anything other than a general correlation between increase in exercise and onset of symptoms is worthwhile. It is surprising that the muscle showed no evidence of fibrosis, yet, if it had, both exercise pain and muscle bulk would have been expected to diminish.

Pathogenesis—The possible etiological factors in this condition have been discussed at length by Hughes (1948) and by Carter, Richards and Zachary (1949). Always present are the anatomical factors of the configuration of the anterior tibial compartment with its rigid walls and the vascular pattern of the muscles of that compartment. It seems probable that the former is of major importance, and it is unlikely that the so-called " open " lower end of the compartment is anything more than a potential opening well occupied by tendons and thus unsatisfactory as a " safety-valve." With increasing tension within the compartment " circulation within the intramuscular vascular networks is embarrassed " (Hughes 1948), and ischaemia leading to necrosis results. This necrosis may not be uniform, but it seems to affect the tibialis anterior and extensor hallucis longus to a greater extent than the extensor digitorum longus (Carter, Richards and Zachary 1949). It is doubtful whether this is of any significance, and whether the source of the muscles' blood supply is important, because if tension is a major factor the pressure will be uniformly distributed on the smaller intramuscular vessels. The increase in tension can be brought about in different ways. It can occur after a direct injury with or without fractures of one or both bones of the lower leg, and nineteen of the reported cases are of this nature. Carter, Richards and Zachary (1949) reported two cases in which a rise in tension followed blood transfusion, presumably with leakage of fluid into the compartment. However, the most common and interesting cause of increased tension is the muscle swelling which normally follows exercise, but which may be excessive or exaggerated by " rupture of a few muscle fibres or by haemorrhage into the muscles " (Carter, Richards and Zachary 1949) after over-exertion. This over-exertion is commonly marching or playing football. Howard (1937) described the changes in fatigued muscle and found an increase in bulk to be an important factor. It is pertinent that gross oedema with consequent increased bulk demands a patent arterial supply, a factor against the possibility of spasm or thrombosis as the cause of the necrosis.

Further evidence against the possible role of arterial thrombosis as a factor in etiology comes from this case, in which there was good anterior tibial pulsation after two years of ischaemic pain. Carter, Richards and Zachary (1949) also noted a normal circulation arteriographically in four cases, and dorsalis pedis pulsation in these and their remaining five cases at a late stage. Furthermore, as Hughes (1948) pointed out, such widespread necrosis as is usually present cannot result from any short thrombosis of the anterior tibial artery at the level of the upper end of the interosseous membrane, a suggested site of trauma and thrombosis, because of the alternative arterial supply available to the muscles from perforating branches of the posterior tibial artery and from the peroneal artery in the lower third of the leg. A long segmental block would be necessary to explain the necrosis on the basis of arterial thrombosis. There has been no evidence of this in the reported cases in which the artery has been resected, and in the cases in which it has not been resected it has been noted to pulsate at the front of the ankle.

There remains the possibility of arterial spasm or abnormal tone in an otherwise normal vessel. Hughes (1948) subscribed to this view, believing that the reason for the spasm was the accumulation of metabolites during exercise, a cause and effect which appears unphysiological. To explain fully the pattern of acute ischaemia which Hughes (1948) described, spasm has to act over a long segment of the anterior tibial artery, and yet be selective, in that the first part of the artery and its recurrent branch must not be involved (Hughes 1948). He also quoted Lewis (1936) and Cohen (1944) as stating that "whatever condition may be responsible for the acute ischaemia, it must have persisted for six to twenty-four hours in order to produce necrosis." This may be asking too much of "spasm." It also seems unlikely that prolonged spasm would not be followed at least in some cases by thrombosis, of which there has been no evidence.

In all the published cases the onset has been acute, and it appears that this is typical of the condition, although in cases without direct injury or a history of excessive exercise it is not clear why this should be so. A previous history of ischaemic muscle pain in the anterior tibial compartment in these cases would be expected, and yet generally it has not been forthcoming. Three of the patients reported, however, did have previous ischaemic symptoms. One of Hughes's (1948) patients complained of "vague pain" over the antero-lateral aspect of both lower limbs for nine months, and Horn (1945) discussed a patient who had noted "pains in both legs during forced marching." Carter, Richards and Zachary (1949) gave clinical details of only two patients, but one of these had a past history of pain in the front of both legs during route marches, and "even before joining the Army at the age of seventeen, had had pain in his legs after severe exercise." In other cases there was no specific mention of a previous history, and it is possible that it may have been overlooked.

It is evident from the case reported here that muscle ischaemia and thus exercise pain in the anterior tibial compartment may be persistent and represent a chronic type of the condition. Under this heading of chronic ischaemia the condition of peritendinitis crepitans has also to be considered. It appears that this condition may develop with excessive or unaccustomed exercise of the anterior tibial muscle group and, according to Howard (1937), who studied the local histological and chemical changes, it is a manifestation of chronic ischaemia of muscles. A milder and much commoner form of the condition, often seen in athletes undergoing training, may be that of "shin splints," described by Pearson, Adams and Denny-Brown (1948). The pretibial tenderness and pain of "shin splints" generally subside as training progresses, but on occasion they demand greater attention and care.

To summarise, it seems probable that increased tension in the anterior tibial compartment is the most important factor in etiology. This rise of tension may be produced in many ways—by direct injury with or without associated fractures of the lower leg bones, by a misplaced transfusion, or by excessive and perhaps unaccustomed exercise of various types. In all cases the ischaemia may be acute and cause replacement fibrosis or muscle necrosis, but in cases without direct injury it may be chronic, producing either persistent pretibial pain on exercise with or without herniation of muscle through the anterior crural fascia or a peritendinitis involving the muscles of the anterior tibial compartment.

Treatment—The possible progression of persistent ischaemia to acute complications should have a bearing on treatment, in that it is important not to dismiss lightly the complaint of exercise pain in the anterior tibial compartment, particularly when this occurs in footballers and athletes, when the exercise that produces it is likely to be repeated frequently. Should the condition be diagnosed in the chronic phase, the patient should be advised to give up whatever excessive exercise produces it, or, if this is impossible, decompression of the anterior tibial space should be undertaken. In such cases the presence of muscle herniae through the anterior crural fascia is of particular significance and indicates that increased tension within the space has existed for a long time. Although not mentioned by recent investigators, the presence of such herniae has been noted before. Sirbu, Murphy and White (1944) described ischaemic

necrosis occurring five days after the repair of a small hernia in the anterior crural fascia. This suggests that repair without fascial transplantation should not be undertaken, as it serves only to increase tension within the compartment.

In the acute phase decompression is an essential emergency measure, and the earlier it is undertaken the more effective it will be. Intervention is worthwhile as late as the fourth day after the onset, because complete recovery has been reported thereafter (Sirbu, Murphy and White 1944), indicating that even with acute symptoms deprivation of blood supply may not be total.

SUMMARY

1. A case of persistent exercise ischaemia affecting the anterior tibial group of muscles is described.

2. Pathogenesis and treatment are discussed. Decompression of the anterior tibial compartment is required if the patient is unwilling to give up whatever activity causes the exercise pain.

I wish to thank Mr G. Gordon Bruce for his encouragement and Mr Andrew Fowler for his permission to publish this case.

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THE VALUE OF RIGID FIXATION IN THE TREATMENT OF FRACTURES OF THE ADULT TIBIAL SHAFT

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This paper records the results of work which has been aimed at testing the thesis that a method of treatment which fixes the bone ends rigidly is desirable in fractures of the tibia and fibula in adults. A consecutive series of thirty-three patients treated by a technique giving rigid fixation is analysed with follow-up results at one year. The influence of rigid fixation on the pattern and time of repair of bone is considered, and histological evidence is produced which shows that bone union can occur after a displaced fracture of the adult tibia in eight weeks.

Judging from the literature, there has been a fall in popularity of the bone plate which is designed to hold the fracture rigidly throughout the period of treatment. Surgeons who practise internal fixation of the tibia with surface appliances appear generally to prefer the Eggers contact splint. The fall in popularity of the standard bone plate seems to be traceable to two main trends of opinion. First, the belief that any method which prohibits all movement at the fracture site removes the essential stimulus to callus formation and thus the fracture becomes indolent; and second, the widely held belief that absorption of bone ends occurs and that any method which keeps the fragments apart after this absorption is likely seriously to impede the natural healing process. Because of these beliefs conservative treatment or the use of the intramedullary nail are the methods enjoying popularity at present.

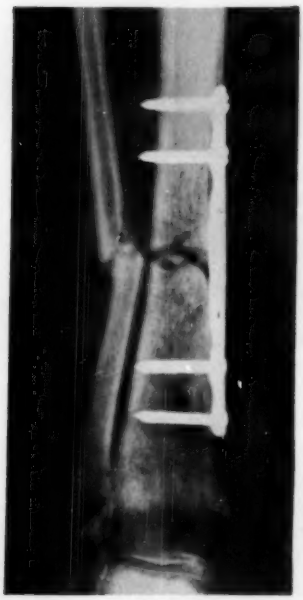

FIG. 1

Non-union of a fracture after plating. The materials used were not adequate to withstand the forces bearing on the fracture.

My definition of union of the fracture in the series of operations here reported is that a fracture of the tibia is united when the patient can walk painlessly without external splintage on the limb, without subsequent deterioration, and when a radiograph shows some progression towards obliteration of the fracture line.

Griffiths (1942), using the same definition of union, analysed the results of an unselected series of 249 fractures of the tibia in patients over sixteen years of age treated by closed reduction and plaster fixation. He found that the mean time for union was sixteen and a half weeks with a standard deviation plus or minus ten weeks. In his series eight fractures developed non-union.

The expression " plating a fracture " has been used to convey many different meanings. Procedures differing in their purpose and effect have been so described. Surgeons have differed in their respect for the soft-tissue covering of the fragments, and their assessment of the presence of bony union has been as individual as their selection of fractures for internal fixation. Lottes, Hill and Key (1952) compared the results achieved by conservative treatment, by plating, and by intramedullary nailing. The fractures upon which plates were applied

were not consecutive fractures. The authors' opinions were based on the hospital records, and three different types of plate were used by many different surgeons. The selection of cases for plating was not disclosed. Of twenty-two simple fractures upon which a plate was applied, 57 per cent were in plaster for over six months, 13 per cent developed non-union, and the average time to reach a state of walking without plaster or other support was ten months. Their paper concluded that, of the three methods they were comparing, treatment with the intramedullary nail was the best. The literature contains no account of a series of cases treated by a standard technique, and it is unreasonable to condemn a procedure when it is uncertain whether it is the procedure itself or its technical execution that is being judged.

If treatment by fixation with a plate is to be judged fairly, it is necessary to know the results of a series of fractures in which the plate imparted rigidity to the fracture. Figure 1 shows the radiograph of a fracture of the tibial shaft in which plating had not been adequate to give rigidity. The fracture is ununited. The material used and the method of its use were inadequate.

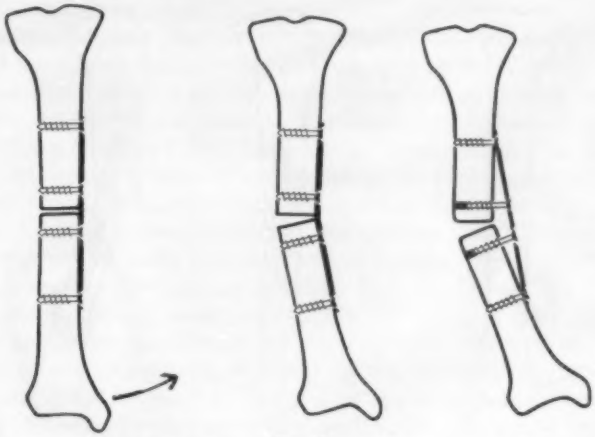

FIG. 2

A force acting in the direction of the arrow will tend either to bend the plate or to pull out the screws nearest to the fracture. This is the force against which the standard plating equipment provides the least margin of safety.

The technique used in the series here reported has been evolved to give the greatest degree of fixation obtainable with standard equipment and without exposing more than one surface of the bone.

THE TECHNIQUE OF RIGID FIXATION

Mechanical principles—The forces that may displace a well reduced transverse fracture of the mid-shafts of the tibia and fibula may be analysed as follows. *Angulation towards the plate*—Reference to Figure 2 will show that the tendency for the lower fragment to move in the direction shown by the arrow is resisted by either the strength of the plate or the grip of the screws. *Angulation away from the plate*—Stability of the fracture depends upon the linking action of the plate and the accuracy of the reduction (Fig. 3). *Angulation with the plate side-on*—It will be seen from Figure 4 that movement in the direction of the arrows can occur only if the screw nearest to the fracture breaks at its neck. If both cortices are not gripped by the screw resistance to this force is clearly lessened. *Distraction and rotation forces*—Resistance to these forces depends again on the strength of the screws and upon the width of the plate. A plate firmly attached to a segment of the circumference of a bone imparts resistance to torsion at the fracture proportionate to the segment that is covered.

In attempting to secure rigid fixation we have therefore to consider the strength of the plate, the fixation of screw to bone, and the fixation of screw to plate. As Hey Groves (1921) showed, the greatest rigidity is achieved if plates are bolted to the bone, but this technique has the disadvantage of requiring exposure of more than one surface.

Practical application—Most fractures of the tibia are produced by violence tending to create a valgus deformity. If the force be great, the fibula and the soft tissues will rupture on the lateral side and the third or " butterfly " fragment, if any, will have its base laterally and point medially. In fractures from minor violence the fragments will be stable to a varus force because of intact tissues on the lateral side and it is the medial side which needs the linking action of the plate. In this event the tendency to angulation towards the plate is resisted by the strength of the plate and the intact lateral tissues. If there be complete rupture of all tissues from major violence, the commonest state of affairs, there will be no natural stability and fixation will depend entirely upon the plate. This should be screwed to the surface upon

FIG. 3

FIG. 4

Figure 3—A force tending to angulate the fragments away from the plate is efficiently countered by the link-like action of the plate, provided the fracture is well reduced. If there is a gap at the fracture site the force is resisted only by the strength of the plate. Figure 4—Resistance to a force tending to angulate the fracture sideways to the plate depends mainly upon the shearing strength of the screws, for the plate is unlikely to bend in this plane.

which the best fixation can be achieved without further disruption of soft tissues, namely the antero-medial surface. The plate should be maximally resistant to bending at the fracture site and its length should be sufficient to permit the surgeon to insert screws, one on each side near the fracture, and two others as far as possible from the fracture. These are the four key screws and if they are numbered 1, 2, 3 and 4 from above downwards the distance between screws 2 and 3 which straddle the fracture should not be greater than the distances between 1 and 2, or 3 and 4. The length and bulk of the plate should be the greatest consistent with reasonable ease of handling, and the other screws inserted act as second lines of defence for the four key screws.

Screws should possess two properties: first, strong resistance to being pulled out by their heads and, second, resistance to having their heads broken off by lateral force. These criteria are satisfied by one-eighth-inch core diameter stainless steel screws with coarse threads sixteen to the inch. The grip obtained by screws with a greater number of threads per inch is inferior.

An accurate reduction is important because in its absence, especially in transverse fractures, angulation away from the plate is imperfectly resisted. Reduction can sometimes be improved by tapping the heel before finally tightening the fracture clamp, and by making a drill hole not quite concentric with the hole in the plate but slightly off centre in the direction away from the fracture line, so that the final turns of the screw tend further to close the fracture line.

TESTING THE THESIS OF RIGID FIXATION

Between September 1952 and March 1954 all adult patients entering the Manchester Royal Infirmary with suitable fractures of the shafts of tibia and fibula were treated by an operation in which rigid mechanical fixation was the object. All fractures were so treated, simple and compound, unless from the anatomy of the fracture it was considered that two screws could not be inserted into one of the fragments to satisfy the criteria mentioned earlier. Very high fractures and supramalleolar fractures were thus excluded—only four cases in all. Otherwise the group was entirely unselected and the operation and after-treatment conformed rigidly to a predetermined technique.

Technique and after-treatment—The fracture was tested for stability and if it was stable to a valgus force but mobile to a varus force a plate was fixed to the lateral surface of the tibia. In all other cases—thirty-two out of thirty-three—there was no stability and so the antero-medial surface was selected for the plate. With minimal periosteal stripping the fracture was reduced and held in a Charnley (1953) clamp applied in many cases over some of the lateral soft tissues, to avoid stripping them. The only part of the bone from which periosteum was stripped was that part of the antero-medial surface where the plate was to lie. A seven-inch eight-hole Burns femur plate was used and coarse stainless steel screws were inserted into seven sixty-fourth-inch drill holes to penetrate both cortices. " Butterfly " fragments were fitted in as well as possible, with care not to disturb their soft-tissue attachments. All wounds were sutured, including those of compound fractures, and external splintage was not applied. Knee and ankle movements were started the next day, and walking on the normal leg with the aid of crutches was encouraged. Between ten and fourteen days after operation the sutures were removed and a posterior plaster shell was applied to protect the leg against accidental injury at home. Instructions were given that the shell was to be removed twice a day for knee and ankle exercises. Radiographs were taken when the patients returned eight weeks after operation and they were then instructed to walk.

In two patients (Cases 10 and 32) there were double fractures of the tibia with extensive skin wounds and on this account plaster was applied and retained for twelve weeks. In no other patient did the treatment differ from that described above.

Walking was not permitted until eight weeks after the operation because it was felt that even with excellent technical fixation the forces acting at the fracture line would be too great to be opposed by the plate alone.

Table I contains details of the thirty-three patients in this series. All these fractures were unstable except one (Case 22) in which the plate was applied to the lateral surface of the tibia. In all other patients the plate was applied to the antero-medial surface. In Case 32 the double fractures could not be held with one plate and two were therefore used. In all other patients a single plate was applied.

RESULTS

Of thirty-one patients with single fractures of all types, twenty-nine walked without plaster at eight weeks and needed no further treatment. Of the remaining two single fractures, one (Case 2) was compound and there was severe contamination with road dirt which led to wound infection. The other (Case 21) was in a limb affected by severe varicose veins and dermatitis. A subcutaneous haematoma developed and an area of skin necrosis gave rise to deeper infection. The two patients with double fractures of the tibia walked without plaster

TABLE I

CLINICAL DETAILS OF THIRTY-THREE PATIENTS WITH FRACTURES OF THE TIBIAL SHAFT TREATED BY RIGID FIXATION WITH A PLATE

Case number	Age	Sex	Cause of fracture	Type of fracture	Amount of displacement	Compound or simple	Result	Remarks
1	21	F	Motor-cycle accident	Transverse	¼ diameter	Simple	Fair	Delayed union
2	54	M	Motor-cycle accident	Comminuted	⅝ diameter	Compound	Poor	Infection
3	23	M	Football injury	Comminuted	½ diameter	Simple	Fair	Mild infection
4	38	M	Road accident	Comminuted	½ diameter	Simple	Fair	Mild infection
5	43	M	Fall	Comminuted	⅝ diameter	Simple	Excellent	—
6	60	F	Fall	Transverse	¼ diameter	Compound	Excellent	—
7	33	M	Motor-cycle accident	Comminuted	¼ diameter	Simple	Excellent	—
8	21	M	Motor-cycle accident	Transverse	1 diameter	Simple	Excellent	Plate removed
9	41	M	Road accident	Comminuted	¼ diameter	Simple	Excellent	—
10	28	M	Road accident	Double	1 diameter	Compound	Excellent	—
11	54	F	Fall	Comminuted	⅝ diameter	Simple	Excellent	—
12	43	M	Road accident	Transverse	1 diameter	Compound	Excellent	—
13	63	F	Road accident	Transverse	1 diameter	Compound	Excellent	—
14	52	M	Road accident	Comminuted	½ diameter	Simple	Excellent	—
15	40	M	Motor-cycle accident	Comminuted	½ diameter	Simple	Excellent	—
16	56	F	Road accident	Comminuted	½ diameter	Simple	Excellent	—
17	32	M	Road accident	Transverse	¼ diameter	Compound	Excellent	—
18	71	M	Road accident	Transverse	¼ diameter	Simple	Excellent	—
19	48	M	Motor-cycle accident	Transverse	1 diameter	Simple	Fair	Delayed union
20	43	F	Fall	Short oblique	½ diameter	Simple	Excellent	—
21	58	M	Fall	Short oblique	½ diameter	Simple	Poor	Infection
22	54	F	Fall	Short oblique	¼ diameter	Simple	Excellent	—
23	65	M	Road accident	Comminuted	1 diameter	Simple	Fair	Angulation
24	49	M	Road accident	Transverse	1 diameter	Compound	Fair	Delayed union
25	62	F	Fall	Oblique	½ diameter	Simple	Fair	Angulation
26	37	F	Road accident	Oblique	½ diameter	Simple	Excellent	—
27	18	M	Motor-cycle accident	Transverse	1 diameter	Compound	Excellent	Plate removed
28	27	M	Fall	Transverse	½ diameter	Simple	Excellent	—
29	21	M	Motor-cycle accident	Transverse	½ diameter	Simple	Excellent	—
30	52	M	Road accident	Transverse	¾ diameter	Compound	Excellent	—
31	38	M	Fall	Transverse	½ diameter	Simple	Excellent	Biopsy taken
32	72	M	Road accident	Double	Both ½ diameter	Simple	Excellent	—
33	70	M	Road accident	Short oblique	½ diameter	Simple	Excellent	—

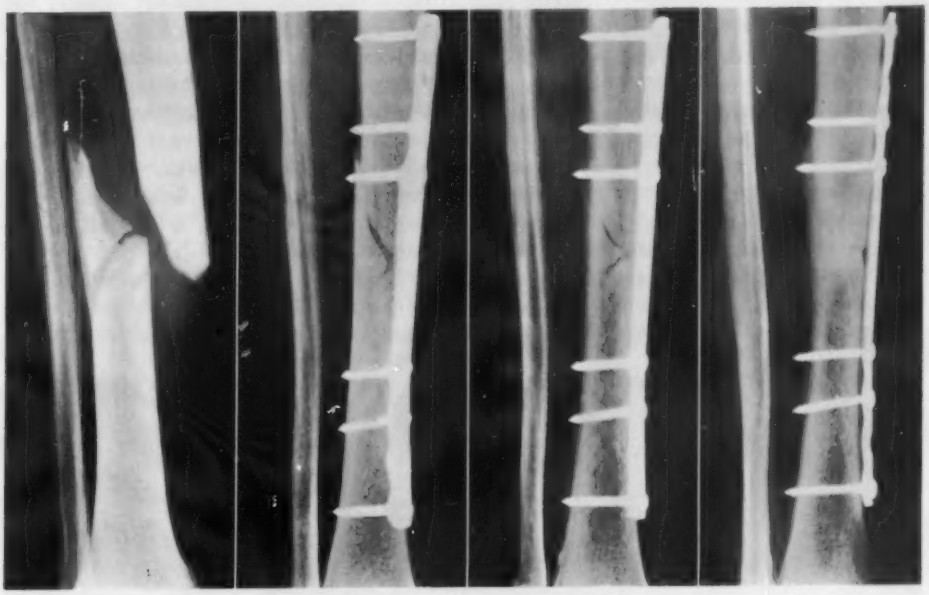

FIG. 5 FIG. 6 FIG. 7 FIG. 8

Case 30—Patient aged fifty-two. Figure 5—Initial radiograph. Figure 6—After plating. Figure 7—At eight weeks. Figure 8—At six months.

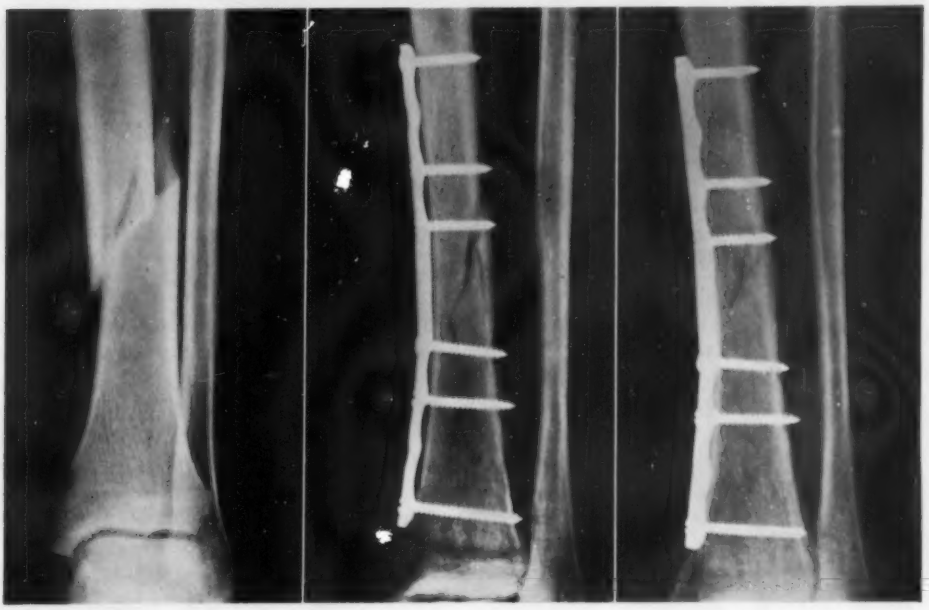

FIG. 9 FIG. 10 FIG. 11

Case 25—Patient aged sixty-two. Figure 9—Initial radiograph. Figure 10—At eight weeks. Figure 11—At six months.

at twelve weeks and they too needed no further treatment. Non-union did not occur in any fracture in this series.

The result was described as " excellent " when the patient left the hospital with a full range of knee and ankle movement and a healed incision at about the fourteenth day after operation, and began to walk at eight weeks after the operation, developing no further trouble of any kind up to the follow-up examination at one year. There were twenty-two in this group. The time taken to progress from walking on crutches to full weight bearing varied with the age and general condition of the patient, but in all cases it was complete by the twelfth week. Pain and limitation of joint movement were not seen in this group and swelling was minimal. Illustrative radiographs are shown in Figures 5 to 18.

Seven patients were classed as having a " fair " result. Two patients developed mild infection which cleared up with chemotherapy and after removal of the plate after eight weeks, the fractures uniting readily. Two fractures angulated despite seemingly rigid fixation at

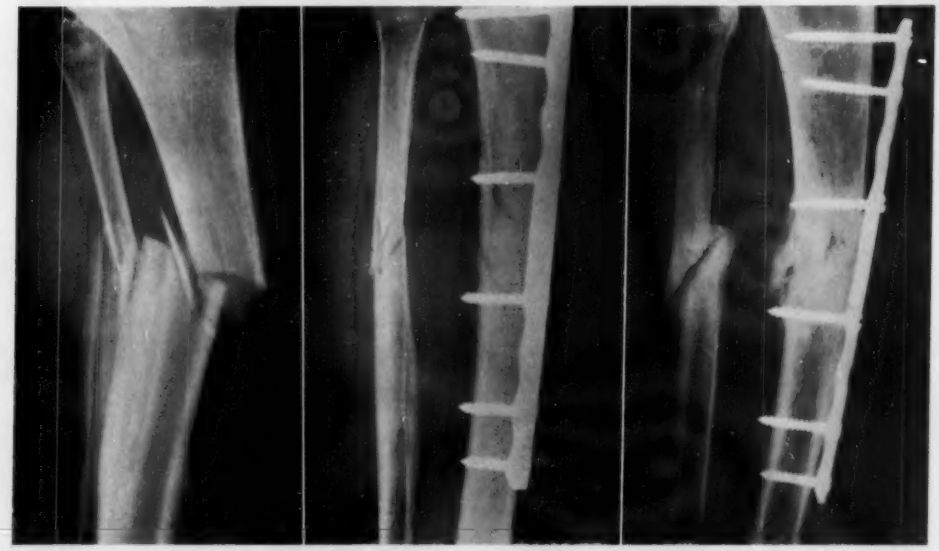

FIG. 12 FIG. 13 FIG. 14

Case 23—Radiographs illustrating failure to maintain rigid fixation because screws gripped poorly in the soft bone. Figure 12—Initial radiograph. Figure 13—After plating. Figure 14—At three months.

operation. Both these fractures were high in the shaft in patients over sixty years of age, and the failure is ascribed to a poor grip of the proximal screws in the cancellous upper tibia (Figs. 12 to 14). The deformity in these two patients was slight and no further treatment was called for. Three fractures showed delayed union. These patients walked at eight weeks but radiographs failed to show any change at all until six months in two cases and nine months in the third. They had slight pain and showed a lack of confidence in walking, when compared with those in whom the fracture was becoming obliterated at eight weeks. Radiographs showed bone union at one year, the tibiae having been rigid to clinical examination throughout (Figs. 15 to 18). Two of these three fractures were grossly displaced compound injuries.

Two patients were classed as having a " poor " result. Both developed wound infection, and when the plate was removed at eight weeks the fracture was found to be mobile and to have undergone no repair. The circumstances of these two have already been referred to. The fractures were treated in plaster after obtaining wound healing and united without bone graft in six months and nine months respectively.

All these thirty-three patients returned to their original occupations, and one year after operation only one patient (Case 21) was still attending hospital.

The repair process—Most of the fractures reported here showed a gradual obliteration of the fracture line with minimal callus formation and no radiological evidence of absorption at the bone ends. The factor common to the three cases of delayed union was marked periosteal stripping. In two this was caused by the injury, and in the third by the operation.

I believe that rigid fixation of a fracture enables the process of repair to proceed more quickly and more economically than in fractures where movement is permitted, provided this rigid fixation can be obtained without jeopardising the viability of the bone ends. Figures 19 and 20 show the repair process in Case 31 eight weeks after the fracture. The specimen was taken from the lateral surface of the tibia near the crest. New bone is seen spreading from the surface of one fragment to that of the other both periosteally and endosteally. There is very little cartilage and the fibrous callus between the bone ends is

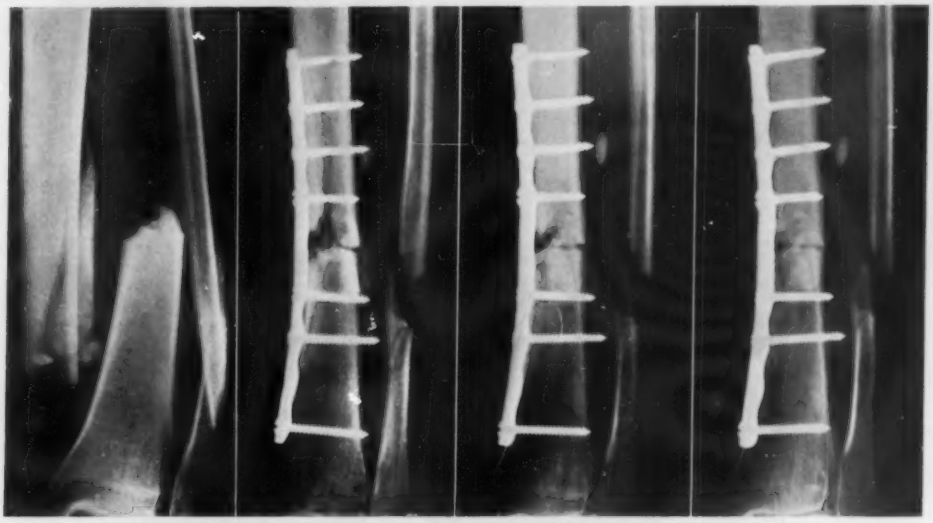

FIG. 15 FIG. 16 FIG. 17 FIG. 18

Case 24—Delayed union ascribed to death of the bone ends incurred at the original injury. Evidence of union was first seen at nine months. Figure 15—Initial radiograph. Figure 16—At eight weeks. Figure 17—At four months. Figure 18—At nine months.

being invaded by islands of new bone without the intermediary of cartilage. The cortices themselves contain dead bone cells and are not playing any part in the repair process other than providing surfaces on which the woven bone is forming. This is true bony union occurring in a displaced fracture of an adult tibia at eight weeks. I do not claim that rigid fixation gives bony union in eight weeks in all fractures. Clearly many of the patients reported here walked at first on a tibia whose rigidity was provided by a healing fracture and a plate; but bony union can occur in eight weeks and was surely due, in the example shown, to rigid fixation in a fracture in which the reduction was " hair-line."

DISCUSSION

I have not been concerned here with exploring the advantages and disadvantages of the Eggers contact splint, nor have I entered the controversy as to the occurrence, extent or significance of bone death in this fracture. My object has been to find out what result could be obtained by a technique by which the one goal aimed at was rigid fixation. I feel that

these results are superior to any series of fractures treated conservatively, not only in time to achieve a given result but in the quality of that result. When a fracture of the tibia has been rigidly fixed throughout there is no pain. Joint stiffness, oedema and osteoporosis are minimal

FIG. 19
Case 31—Photomicrograph of biopsy specimen which included the fracture line, excised eight weeks after the injury. (×4.)

FIG. 20
Case 31—Enclosed area of Figure 19 seen at higher magnification. The outer layer of the cortex of one fragment is seen below and to the right. Above this on the right is a mass of woven bone invading the fibrous callus of the fracture line, seen in left lower corner. (×55.)

and I feel that these signs develop only when union is progressing with difficulty.* They are seen mainly in fractures treated conservatively, and, no matter how well the plaster be applied, it can never give that degree of fixation that is essential for union in ideal circumstances.

* From further recent experience of treating fractures of the tibia by the application of a plate supplemented by plaster fixation, I have confirmed the view that joint stiffness and the other signs enumerated above are caused by the difficulty of fracture union consequent, I believe, on the inadequacy of fixation and not by the plaster immobilisation alone.

Study of Figures 5 to 18 shows the pattern of healing in these fractures, a process of gradual obliteration of the fracture line with very little external callus. It is suggested that this is first intention healing; union proceeding in ideal circumstances, where absence of movement renders massive callus formation unnecessary.

Treatment of fractures of the tibia by the application of a plate may fail if rigid fixation is not achieved and maintained. Union may be very slow if the bone ends are widely stripped, but in this latter event, if the fixation is firm all along, union will result in time. In the absence of infection non-union does not occur in rigidly fixed fractures of the tibia. Delayed union is caused by death of bone ends which may be due to injury but must never result from wide periosteal stripping consequent upon some plating techniques. I consider that this series differs from others reported in that rigid fixation has almost always been achieved and it has been achieved without further damage to the blood supply of the bone. The greatest disadvantage of the routine use of plates for fractures of the tibia is infection, and I now feel that a healthy skin is an essential pre-requisite of the operation.

SUMMARY

1. The thesis is advanced that in the treatment of fractures of the adult tibia rigid fixation is desirable.
2. The mechanical factors are discussed and a technique is described which provides a high degree of fixation without exposing more than one surface of the bone.
3. The process of healing of such fractures is described and the results in thirty-three unselected patients are given.

My thanks are due to Mr D. Ll. Griffiths, in whose department this work was carried out. I am grateful to him and to Mr John Charnley for allowing me the privilege of taking over the care of this fracture. I would like to acknowledge the help of Mr J. H. Hicks. I thank the Department of Medical Illustration of the Manchester Royal Infirmary for the photographic work.

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VASCULAR COMPLICATIONS OF SHOULDER INJURIES

A Report of Two Cases

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Considering the frequency of dislocations of the shoulder and fractures in this region it is surprising how uncommonly the axillary artery sustains damage. Much importance is rightly attached to arterial trauma or spasm as it occurs in relation to elbow injuries. At this site such complications are not uncommon and, if neglected, may produce disastrous results. It is probable that the greater mobility of the axillary artery renders it less vulnerable; and if it is injured the collateral circulation in the healthy adult is usually able to cope with the demands of an acute main-stem occlusion. In elderly patients, however, often the subjects of arterial disease, lack of vessel elasticity may increase the risks of damage and an adequate collateral circulation may be wanting. Under such circumstances there develops a greater threat of dangerous ischaemia, and radical measures become necessary. This is illustrated by the following case reports.

CASE REPORTS

Case 1—A man aged sixty-five was admitted to Paddington General Hospital having fallen and sustained an injury to his right shoulder twelve hours previously. He complained of pain in the shoulder, and of numbness of the hand and lower forearm which had followed a short-lived pain of similar distribution.

On examination there was a considerable deformity of the right shoulder, all movement being prohibited by pain. The hand was cold and blue and there was anaesthesia of the limb distal to a point just below the elbow. Initially, slight active movement of the fingers and wrist was possible but within an hour this had disappeared completely. The fingers and wrist were held in a position of flexion, which also increased during this period. Any attempt to extend passively these fingers produced considerable pain. High in the axilla a pulse could be felt but below this level the limb was pulseless. A radiograph showed a severe fracture-dislocation of the shoulder (Fig. 1). The deterioration already referred to occurred during preparation for operation in spite of reflex heating.

Under anaesthesia the shoulder was manipulated but there was no improvement in the colour of the hand nor any return of the pulse. Accordingly the shoulder and axilla were exposed by a modified Henry's approach (Henry 1946). The brachial plexus was macroscopically intact, but the axillary artery at the origin of its subscapular and circumflex humeral branches was trapped behind the sharp medial edge of the lower fragment (Fig. 1). It was freed without any return of the pulse. Papaverine was applied to the vessel wall, which was moderately arteriosclerotic, but with no effect. The artery was therefore opened, and it was found that, although the wall was externally intact, the intima was torn and had undergone dissection for about one inch with superimposed thrombosis. The affected segment was resected and propagated thrombus removed until a good flow was obtained from each divided end. It appeared that an arterial graft would be necessary to bridge the gap, but in view of the comminution it was decided to remove the humeral head. The resultant shortening of the limb allowed an end-to-end anastomosis to be performed without undue tension.

After operation there was an immediate return of a normal radial pulse associated with a marked reactive hyperaemia of the affected limb. Rapidly the fingers lost their flexed position and regained voluntary movement. The anaesthesia disappeared and sensation

FIG. 1
Case 1—Radiograph of the right shoulder showing a severe fracture-dislocation.

FIG. 2
Case 1—Arteriograph after successful resection and anastomosis of the contused axillary artery. The anastomosis is just level with the axillary border of the scapula.

became normal apart from gradually diminishing paraesthesiae of the hand and fingers which cleared up completely in the course of a few days. Further progress was uneventful, and with the institution of physiotherapy a fair degree of movement and control of the shoulder was obtained.

An arteriograph (Fig. 2) before the patient's discharge showed the anastomosis to be patent and satisfactory. It will be seen that there is no direct filling of the subscapular or circumflex humeral arteries, which arose from the injured segment of vessel which had to be resected.

Case 2—A man aged seventy-two was admitted to St Mary's Hospital having fallen and injured his left shoulder some four hours previously. He complained of pain in the shoulder and numbness of the hand.

On examination there was the typical deformity of a sub-coracoid dislocation of the left shoulder, which was confirmed radiologically. The left hand was cold and white and, although not completely anaesthetic as in Case 1, there was definite diminution of sensation. There was no voluntary movement of either the wrist or fingers. No pulse could be felt below the level of the subclavian artery.

Under anaesthesia the dislocation was reduced. The axilla could now be examined more easily. The axillary artery could be felt pulsating in the upper part of its course but no pulsation could be felt below thi. level. Conservative vasodilatory methods were adopted, including reflex heating and the administration of antispasmodics, and this policy was pursued for about four hours. At the end of this time the distal pulses were still absent and, far from there being any improvement in the limb, its condition had deteriorated. In particular, the fingers had now assumed a flexed position as in Case 1, and similarly attempts at passive extension were limited by pain.

In view of this lack of improvement it was decided to explore the axilla. The brachial plexus appeared intact but, in spite of remarkably little haematoma formation, the axillary artery was found completely severed immediately below the origin of its subscapular and circumflex humeral branches. The whole artery and its branches were markedly arteriosclerotic and at the point of disruption there was a degree of aneurysmal dilation. This area was resected. The occluding thrombus was removed from each end of the vessel until a good blood flow was obtained. An end-to-end anastomosis was performed without resource to grafting and with preservation of the subscapular and circumflex humeral arteries.

After operation the radial pulse was found to have returned and this was followed by a disappearance of the ischaemic signs and symptoms, with return of finger movements and normal sensation.

Both patients were put on large doses of penicillin but neither was given anticoagulant drugs. The reason for this was the desire to avoid haematoma formation or the necessity of lengthy drainage and the consequent possibility of sepsis in patients with open joint cavities.

DISCUSSION

In both cases, but particularly in the second, the vessels had lost the normal degree of elasticity, perhaps predisposing to their damage, while the aneurysmal dilation present in the last case must have certainly been an important factor. Lesser pathological changes than this have resulted in spontaneous rupture of the axillary artery (St John, Scudder and Stevens 1945). The site of the trauma was practically identical in both patients and the local fixation afforded by the origin of the large circumflex humeral and subscapular arteries may have played some part in determining this. A case has been reported of rupture of the axillary artery at a similar site after shoulder dislocation (Kirker 1952).

The fact that neurological damage is commoner than the arterial complications of shoulder injuries might lead one to ascribe the motor and sensory disturbances of ischaemia

to a lesion of the brachial plexus. The distribution of the paresis and anaesthesia, the absent pulse and the increasing and ominous flexion of the fingers should point to the true state of affairs. To these features may be added the colour and temperature changes in the limb, although in the presence of good collaterals these may be absent—as in the case described by Kirker. This author also stresses the significance of appreciating the vascular disorder, a matter of even greater importance when the signs indicate inadequate collateral circulation. Such was the situation in the cases reported here, the first patient losing important collaterals by involvement at their origin in the contusion, the second through gross arteriosclerosis. In such circumstances conservative measures, unless producing marked results, should be abandoned at an early stage lest irreversible ischaemia supervene.

At operation both patients illustrated an important technical point. This was the necessity of thorough removal of propagated thrombus, particularly from the distal end of the artery. It was achieved in the usual manner by suction applied to a polythene tube passed down the distal segment of the artery. Not until thrombus extending as far as the brachial bifurcation was withdrawn did a good back flow result from the distal end. Although grafts were available, the insertion of an arterial homograft was not indicated in either case. The lack of an arterial graft should not determine a conservative policy if operation is otherwise indicated. In the event of an end-to-end anastomosis being impossible, the defect could well be bridged by a reversed autogenous saphenous vein graft.

Age is likely to be an indication rather than a bar to operation. Without it gangrene may be rare, but by timely surgery we may avoid muscle ischaemia with all its crippling deformity.

SUMMARY

1. Two cases of arterial damage complicating shoulder injuries are reported.
2. The treatment is described and the importance of early diagnosis is stressed.
3. Operation was indicated in both cases by developing ischaemia in spite of conservative measures.

I should like to thank Professor C. G. Rob, Mr J. L. Stephen and Mr H. H. G. Eastcott for allowing me to publish these cases and undertake the operations. I wish to thank the Photographic Department of St Mary's Hospital for the photographs.

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ALKAPTONURIC ARTHRITIS

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Alkaptonuria is a rare inborn error of metabolism in which occurs a defect in the breakdown of the amino acids phenylalanin and tyrosin. Katabolism stops at the stage of homogentisic acid, which is excreted in the urine. There it slowly oxidises, producing the characteristic dark colour. The disease is inherited as a Mendelian recessive character.

Almost all alkaptonurics by the time they reach middle life develop ochronosis, a pigmentation of the cartilage and fibrous tissues of the body. Secondary degenerative changes in articular cartilages and intervertebral discs cause a widespread arthritis. Less than one hundred cases of this form of arthritis have so far been described.

Clinical features—Few instances have been recorded in patients under thirty and most have reached forty before joint symptoms are noticed. Although alkaptonuria has an approximately even sex distribution, alkaptonuric arthritis is much more common in men.

Although most patients develop a stiff spine, only about half of them have serious pain in the back. Deformity, never great, is caused by narrowing of the intervertebral discs. The joints of the shoulder girdle are frequently involved, usually the gleno-humeral joint, but sometimes, as in the case described by Leslie (1943), the sterno-clavicular joint. Knees and hips are affected but the smaller joints rarely so.

Radiology—Radiographs of the spine in established ochronosis are diagnostic. The thoracic and lumbar discs become narrow and calcified. The calcification is diffuse throughout the disc, sparing only the peripheral few millimetres and the hyaline plates against the vertebral bodies. It is also discrete from the osteophytic lipping on the vertebral margins. In a few cases calcification is inconspicuous, or is restricted to a thin stripe, but the disc spaces are narrowed almost to obliteration with sclerosis of adjacent bone and osteophytes (Sacks 1951, Crissey and Day 1950).

In the larger limb joints the main radiological feature that may distinguish ochronosis from osteoarthritis is periarticular calcification (Pomeranz *et al.* 1941).

Pathology—In the lumbar spine the intervertebral discs become narrowed, deeply pigmented and almost bony hard. The costal cartilages show similar changes (Oppenheimer and Kline 1922). Microscopically there is diffuse pigmentation of hyaline cartilage with granular pigmentation of the perichondrium. Fibrocartilages show areas of hyaline degeneration which are discoloured and friable. The cartilage cells become small and pyknotic (Crissey and Day 1950).

In the large diarthrodial joints the pigmented articular cartilage flakes away. There is synovial thickening and peripheral osteophyte formation (Hertzberg 1945).

CASE REPORTS

Two further cases of alkaptonuric arthritis are here described.

Case 1—Electrician aged fifty-three. This man provided one of Garrod's original cases of alkaptonuria and is mentioned in his classic account of the disease (Garrod 1909). His parents were first cousins and their fourth child was found to have alkaptonuria. The fifth child, the patient described here, was seen by Garrod soon after birth and the diagnosis was confirmed on the third day of life. The elder brother, who died at the age of fifty-three from a strangulated hernia, reportedly had arthritis of the spine.

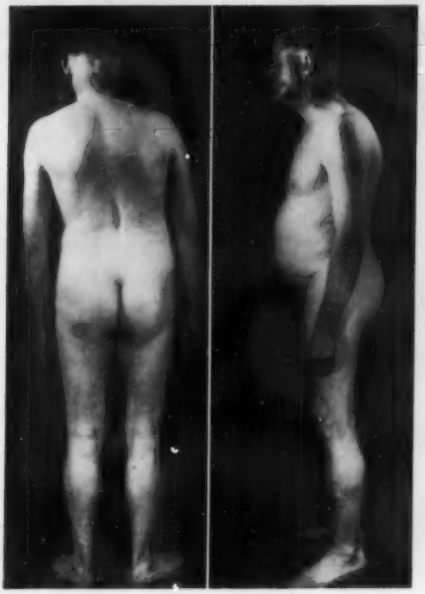

FIG. 1
Case 1—Photographs showing the fixed kypho-scoliosis.

FIG. 2
Case 1—Thoracic spine showing narrowed, calcified intervertebral discs.

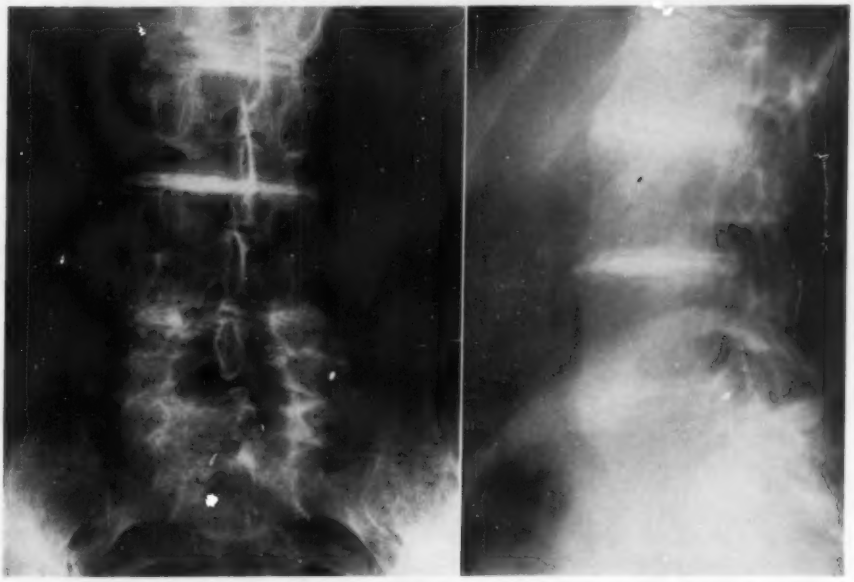

FIG. 3
Case 1—Lumbar spine.

At twenty-nine the patient began to suffer left-sided abdominal pain and increased frequency of micturition, attributed to a homogentisate calculus. He otherwise remained little affected by his complaint until he was forty, at about which time his back was noticeably stiffer

FIG. 4
Case 1—Symphysis pubis. There is narrowing of the interpubic space with blurring and sclerosis of the adjacent bone.

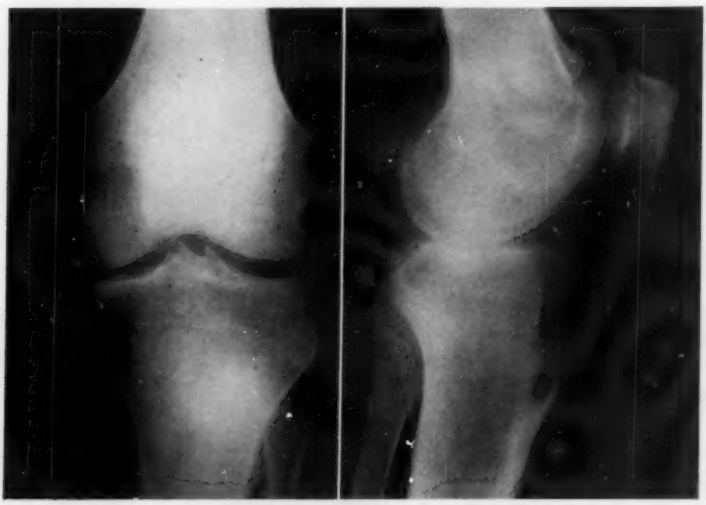

FIG. 5
Case 1—Left knee. The radiographic appearances resemble those of osteoarthritis. The right knee was similar.

than normal and occasionally painful. At forty-seven he was investigated for recurring left-sided abdominal pain which was now thought to be referred from the spine. That he was little troubled by the increasing stiffness of his back is shown by his ability to play tennis regularly

until the age of fifty-one. At no time has he had severe pain in the spine. When fifty-two he developed discomfort and stiffness of the knees, which has persisted, limiting his activities a little although he is still able to do his full work as a maintenance electrician. He had a bilateral inguinal herniorrhaphy when thirty-five, but the ruptures recurred and further operations were carried out, the left at forty-seven and the right at fifty-one. Convalescence from all the operations was uneventful. He has also had a tonsillectomy and suffered from enteric fever, scarlatina and diphtheria.

Clinically he shows evidence of ochronosis in the small pigmented patches in the whites of his eyes and in a blueness of the auricular cartilages. The pinna of each ear feels stiffer than normal. There is a kyphoscoliosis (Fig. 1) and almost complete immobility of thoracic and lumbar spine. The neck shows only slight restriction of movement. Both knees contain excessive synovial fluid and show a little periarticular thickening. The range of movement is 170–80 degrees in the left, 175–40 degrees in the right.

The radiographs are illustrated in Figures 2 to 5. They show the characteristic narrowing and calcification of the intervertebral discs. In the knees the joint space is narrowed and marginal osteophytes are seen, particularly on the patellae. The symphysis pubis is blurred and sclerosed with new bone formation inferiorly.

Investigations included intravenous pyelography, a cholecystogram and barium meal, and blood count, erythrocyte sedimentation rate, urine examination and test meal. All were normal in result, excepting only the presence of homogentisic acid in the urine, which was shown to be present by all the usual tests (Harrison 1947).

Case 2—Married woman aged fifty-seven. There was no history of consanguinity in the parents. In early life it is said that any clothes she soiled with urine were " ruined " by the stain that developed. She first noticed backache when thirty-nine years old and the pain was at

FIG. 6
Case 2—Right eye showing subconjunctival pigmentation.

times severe. She attended an osteopath for manipulations and massage for several years. The true nature of her complaint was not recognised until she was forty-six. She then had occasion to accompany her younger brother to see Dr George Graham for suspected brucellosis. Dr Graham noticed pigmentation of the sclerotics in brother and sister and had the unusual experience of diagnosing this rare disease in both. Her brother died when fifty-one years old from carcinoma of the lung. It is said that he had "a bad back and black spots on his ears." She has a second brother who does not suffer from alkaptonuria.

FIG. 7

Case 2—The lower two cervical joints show marked degeneration. There are also calcified cervical lymph nodes.

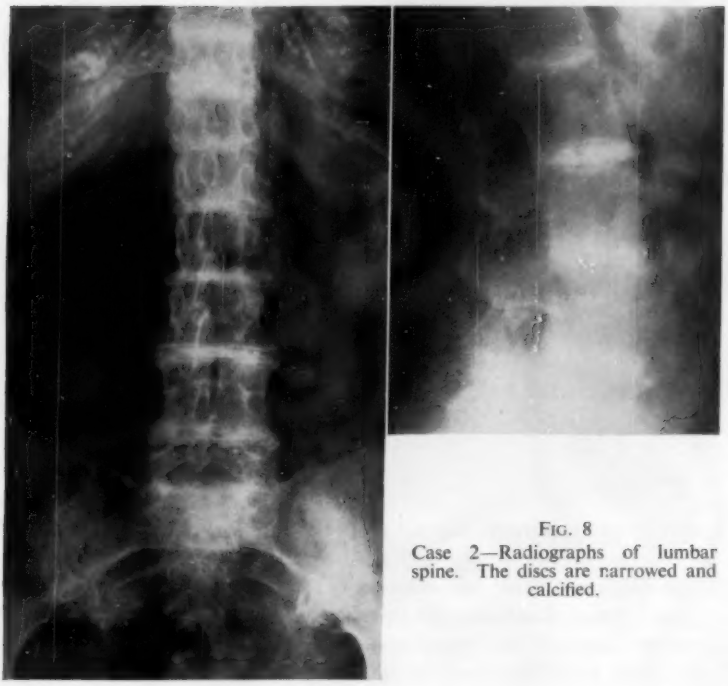

FIG. 8

Case 2—Radiographs of lumbar spine. The discs are narrowed and calcified.

Although the severe pain in the back has subsided she still gets considerable discomfort which was aggravated a year ago by a fall. When fifty-five she had a Fothergill operation for uterine prolapse. About twelve months later aching pain over the pubic symphysis began. This slowly became worse, interfering with her walking. She has also had pain and stiffness in the left shoulder for the past year.

FIG. 9
Case 2—The symphysis pubis is narrowed, with bone erosion inferiorly and some sclerosis.

FIG. 10
Case 2—Radiographs of the shoulders show narrowing of the joint space and lipping, most marked on the left.

The patient has travelled widely in India and Canada, and had dysentery in 1922. She has two children who show no evidence of alkaptonuria.

On examination she showed well developed pigmentation of the sclerotic in each eye (Fig. 6). The right ear in particular was blue and stiff. Although there was no deformity of the spine, movements in the thoracic and lumbar region were almost completely absent.

Movements of the neck were about half normal and abduction at the left shoulder was limited to 100 degrees. There was tenderness over the symphysis pubis and pain on contracting or stretching the adductor muscles.

The radiographs (Figs. 7 to 10) were typical. In this case there were gross degenerative changes in the lower two cervical joints. Mottled calcification of the costal cartilages was well shown and there was erosion, blurring and sclerosis of the pubic symphysis. In the shoulders narrowing of the joint space, sclerosis and lipping were seen, particularly on the left.

The urine contained homogentisic acid. The haemoglobin at the time of examination was 79 per cent, leucocytes were 10,000 per cubic millimetre and the erythrocyte sedimentation rate was 20 millimetres in one hour.

DISCUSSION

The presence of joint disease in alkaptonuria was first pointed out by Albrecht and Zdarek in 1902 (Hertzberg 1945) and has since been mentioned by many writers. It must be distinguished from the common degenerative osteoarthritis. The articular cartilage becomes pigmented, hard and brittle rather than soft and fibrillated. Once the cartilage has started to wear away the secondary synovial, capsular and bone changes are alike in the two diseases. The tendency for alkaptonuria to affect the shoulder joints further distinguishes it from osteoarthritis.

In the spine the only condition with which it can be compared is ankylosing spondylitis, but the similarity is not close. The primary change is in the discs rather than the ligaments and interarticular joints. In fact the anterior longitudinal ligament is conspicuously not affected in ochronosis (Oppenheimer and Kline 1922): nor do the sacro-iliac joints become fused.

Although Hertzberg (1945) reported that the " foremost part of the pelvis was sclerotic " in his patient, little emphasis has so far been laid on the changes seen at the symphysis pubis in both the patients here described. The radiographic appearances resembled those in post-operative osteitis pubis. In Case 2 there had been clinical evidence of this disease. Both patients had had surgical intervention in the immediate neighbourhood of the pubic bone but in neither was the operation of a type that is usually followed by osteitis pubis. It appears that ochronosis acts as a predisposing factor to osteitis pubis, perhaps by reducing the vitality of the interpubic cartilage.

I wish to thank Mr S. L. Higgs and Mr H. Jackson Burrows for permission to report these two patients, who were shown at a clinical meeting of the British Orthopaedic Association at St Bartholomew's Hospital on October 22, 1954. The clinical photographs were taken by Mr N. K. Harrison of the Photographic Department, St Bartholomew's Hospital.

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FAMILIAL INFANTILE COXA VARA

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Case 1—A man of thirty-six sought advice because he had wrenched his left hip while cycling. He had had previous trouble with his hips from the age of eighteen, but the attacks of pain were infrequent and settled rapidly. He worked as a brewery manager with little difficulty. Four years before he attended he had had a piece of bone removed from the right knee for osteochondritis.

Figure 1 shows the radiographs of the hips. There was gross coxa vara, probably of the Fairbank or infantile type with superimposed osteoarthritic changes, more marked on the left side.

FIG. 1
Case 1.

The pain in the left hip caused by the wrench while getting on a bicycle disappeared with a week's rest and he was, he said, in his normal condition. There was about 30 degrees' flexion deformity and flexion to a right angle on both sides—the left a little better than the right.

When seen a year later the patient reported that he had had no further severe symptoms.

Case 2—At that time his first child, a girl, was five months old. I obtained his permission to have the child's hips radiographed, but the films at that time showed no evident abnormality (Fig. 2).

However, I asked to see the child again in two years, and the radiographs taken then showed the typical triangular fragment with its base on the lower border of the femoral neck (Fig. 3). Figures 4 and 5 show the condition one and two years later.

FIG. 2
Case 2—Initial radiograph.

FIG. 3
Case 2—Two years later.

FIG. 4
Case 2—After three years.

FIG. 5
Case 2—After four years.

FIG. 6
Case 3.

FIG. 7
Case 4

The abnormality is present in both hips, but no actual slipping has occurred, and in the latest radiograph (Fig. 5) the abnormal epiphysial line where it cuts the lower border of the femoral neck appears to be closing. The family tree is shown in Figure 8.

Case 3—The radiographs of the first patient's sister (Mr Walton's patient) are shown in Figure 6. There is severe bilateral osteoarthritis of the hips at the age of thirty-two, but no coxa vara.

Case 4—The radiographs of this patient's daughter, however (Mr Law's patient), revealed a coxa vara of the type described by Fairbank, if not perhaps quite typical (Fig. 7).

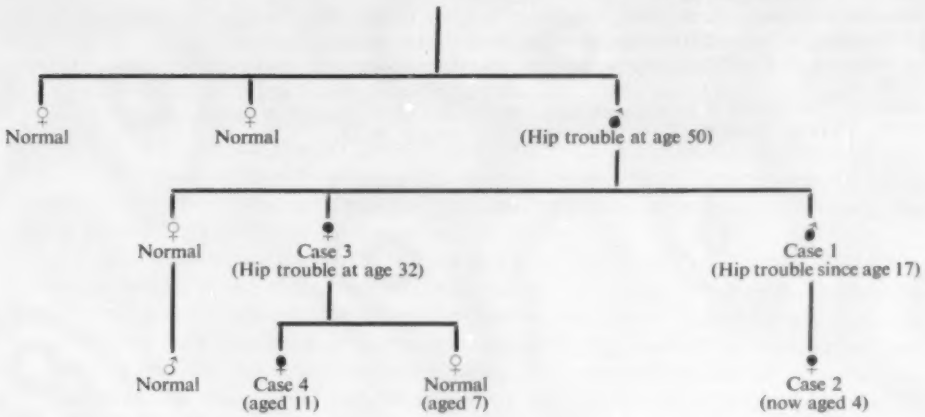

FIG. 8
Family tree including Cases 1–4.

Comment—These cases bring out a number of interesting points. It is clear that infantile coxa vara is a familial condition, certainly in some cases. Two reviews of the condition (Babb, Ghormley and Chatterton 1949, Zadek 1935) failed to mention this fact. Indeed Babb *et al.* stated: "It suffices to say that no hereditary factor has been demonstrated." These authors suggested that a vascular disturbance in early life in the metaphysis might be responsible. In this series, however, the condition appears to be a true primary congenital defect. Jones and Lovett (1923) mentioned a case in mother and daughter, and Fairbank believed it to be a congenital lesion.

Another point shown in this series is that the condition is not necessarily the last phase of congenital short femur, as suggested by Golding (1939), though it can, of course, be associated with congenital short femur. In this case, ossification before the defect appeared in the neck was normal. It is clear also that infantile coxa vara does not necessarily cause slipping.

The supposition of most interest to me arises from the first patient's sister. She has severe bilateral osteoarthritis of the hips at the age of thirty-two, and she produced a child with infantile coxa vara. The mother must have had defective bone or cartilage structure of the femur to wear out her hips in thirty years or so and, moreover, it must have been a congenital defect of resilience. It is notable also that the first patient himself had an osteochondritis of the knee.

We are quite used to the idea of incongruous shape producing osteoarthritis as in Perthes' disease or subluxation, but it seems possible that a congenital defect of structure rather than shape might sometimes operate in the production of osteoarthritic change.

I would like to acknowledge my indebtedness to Mr W. A. Law and Mr L. H. F. Walton for allowing me to report their cases.

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SOLITARY EOSINOPHILIC GRANULOMA OF BONE

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Since eosinophilic granuloma first achieved the status of a pathological and clinical entity in 1940, through the simultaneous publications of Jaffe and Lichtenstein, and of Otani and Ehrlich, a considerable number of papers, mainly by American authors, have appeared on the subject. The histopathology has been thoroughly investigated and described by Green and Farber (1942), Jaffe and Lichtenstein (1944), Ponseti (1948) and others. Its relationship to Hand-Schüller-Christian disease and to Letterer-Siwe disease appears to have been satisfactorily established. Ponseti (1948) concluded that these conditions represent different clinical and anatomical manifestations of the same underlying pathological process, of which the basic feature is reticular hyperplasia. The solitary eosinophilic granuloma of bone is the mildest clinical form of this group of diseases.

Although eosinophilic granuloma of bone may also occur as multiple lesions, Hill (1949), in a comprehensive review of the literature, estimated that in 71·2 per cent of cases it is manifest as a solitary focus, and it is with the latter type that this paper deals. Eight cases are described. Three of those have been encountered in one hospital during the past year, indicating that the lesion is probably not one of excessive rarity. It is thought worthwhile, therefore, to illustrate its radiographic appearances, which are of particular interest in relation to differential diagnosis, and to discuss briefly its pathology, clinical features, and treatment. Two possible complications are also described.

CASE REPORTS

Case 1—A girl aged five years complained of slight pain in her right shoulder, appearing after a fall two weeks before she attended hospital. *On examination*, the lateral part of the right clavicle was found to be thickened and slightly tender. Clinical examination was otherwise negative.

Radiographs (Fig. 1) showed an area of destruction in the lateral half of the right clavicle, partly involving the cortex, and a considerable amount of surrounding subperiosteal new bone formation. A fine crack fracture through the bone at the point of maximum destruction was just discernible.

Investigations—The serum alkaline phosphatase was slightly raised (21·0 KA units per cubic millimetre) and there was a leucocytosis (16,200 per cubic millimetre) with a normal differential count. The remaining routine laboratory tests were normal.

A biopsy excision was done. The pre-operative diagnosis rested between a sarcoma, an eosinophilic granuloma, and a low-grade pyogenic lesion.

Operation—The outer half of the right clavicle, including the whole of the diseased area, was excised. Examination showed that the affected part of the bone contained soft yellowish material replacing the normal cancellous tissue.

Histology—The appearances of this material were those of an eosinophilic granuloma. *Culture* was sterile except for a scanty growth of staphylococcus albus.

Progress—The patient's post-operative course was uneventful. The operation wound healed by first intention and two weeks later she was discharged from hospital, having rapidly regained a full, painless range of movement at the right shoulder joint. Ten months later she remained free from symptoms and further radiographs showed no recurrence of the lesion.

Case 2—An engineering fitter, aged thirty-nine years, complained of pain in the right shoulder region of five weeks' duration. He had received a blow on that shoulder one week before the onset of symptoms. *On examination*, there was a tender swelling over the medial part of the right clavicle. Movements of the right shoulder joint were full and painless.

Radiographs (Fig. 2) showed an area of destruction in the right clavicle adjacent to, but not involving, the sterno-clavicular joint. The inferior cortex at the site of the lesion was thinned and eroded, and there was some subperiosteal new bone formation at this point.

Investigations—Laboratory tests, including the differential white cell count and haematological examination of the bone marrow, were normal.

A provisional diagnosis of multiple myelomatosis was not supported by further radiographic or by laboratory investigations, and so a biopsy was done.

Operation—The medial end of the right clavicle was exposed, and its cortex removed to reveal what

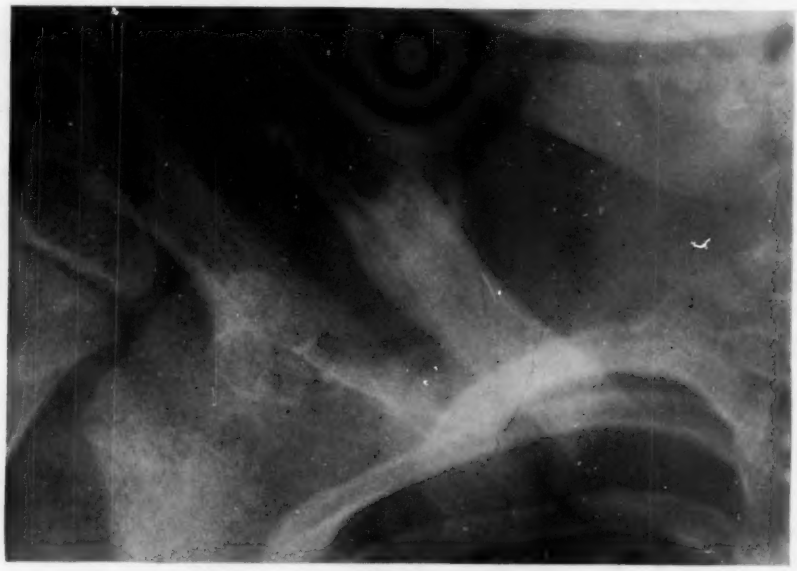

FIG. 1

Case 1—Showing destructive lesion of lateral half of clavicle, with subperiosteal new bone formation; fine crack fracture just visible.

FIG. 2

Case 2—Showing destructive lesion at medial end of clavicle, with erosion of inferior cortex, and subperiosteal new bone formation.

appeared to be a soft, yellowish tumour mass. The medial third of the clavicle, including the whole of the diseased area, was excised.

Histology—The appearances were those of an eosinophilic granuloma.

Progress—The patient's post-operative course was uneventful. When examined one month later he was free from symptoms. As he then removed to another part of the country no detailed follow-up

was possible, but his reply to a recent questionnaire indicates that, five years after the operation, his only complaints consist of slight weakness of the right shoulder and slight aching in that region, particularly when the upper limb is dependent for long periods.

Case 3—A motor mechanic, aged twenty-four years, had first noticed a lump on his left arm two weeks before attending hospital. The lump had enlarged rapidly and become increasingly painful.
On examination, a firm, tender tumour three inches in diameter was found arising from the antero-lateral aspect of the left humerus, about the level of the deltoid insertion. The overlying skin was not involved, and there was no adenopathy.
Radiographs (Fig. 3) showed a small area of destruction immediately under and involving the cortex of the left humerus. There was no evidence of periosteal reaction.
Investigations—Routine laboratory tests were normal.

FIG. 3

FIG. 4

Case 3. Figure 3—Small destructive lesion involving cortex of humerus. Figure 4—Seven months later, resolution complete, with slight residual thickening of cortex.

A biopsy was done. Although the radiographs were atypical of either condition, the rapid growth of the tumour suggested osteomyelitis or a malignant neoplasm.
Operation—The affected area of the left humeral shaft was exposed. The substance of the overlying brachialis muscle was found to be infiltrated by gritty material. The muscle and the periosteum were firmly adherent to the underlying bone. After the bone had been cleared, a defect, an inch in extent, was found in the cortex, through which a small amount of soft, yellow-brown material was removed with a curette.
Histology—The appearances of the curettings from the medullary cavity were considered to be those of an eosinophilic granuloma. A piece of the overlying muscle was also examined and found to be normal, apart from the presence of spicules of new bone formation.
Progress—The patient's pain was relieved after the biopsy operation. The swelling resolved, and when the arm was last examined seven months later the only clinical abnormality was a slight residual thickening of the humeral shaft. The radiographs at that time showed complete recalcification of the original defect, with slight residual thickening of the cortex, and a minor degree of ossification in the overlying soft tissue (Fig. 4).

Case 4—A housewife, aged thirty-two years, complained of pain in her right lower ribs of six weeks' duration. *On examination*, there was tenderness accurately localised to one point on the tenth right rib.

Radiographs (Fig. 5) showed a small, irregular destructive lesion of this rib, with disappearance of a section of the cortical outline on its inferior border, and a little subperiosteal new bone formation.

A biopsy was done. The differential diagnosis lay between a secondary malignant deposit and an infective lesion.

Operation—The right tenth rib was exposed in the posterior axillary line, and the lesion identified. The cortex of the rib was found to have been penetrated by granulation tissue. A two-inch piece of the rib, containing the lesion, was excised.

Histology—The appearances were those of an eosinophilic granuloma.

Progress—The patient's post-operative course was uneventful. Serial radiographs over a follow-up period of nine months showed no recurrence of the rib lesion.

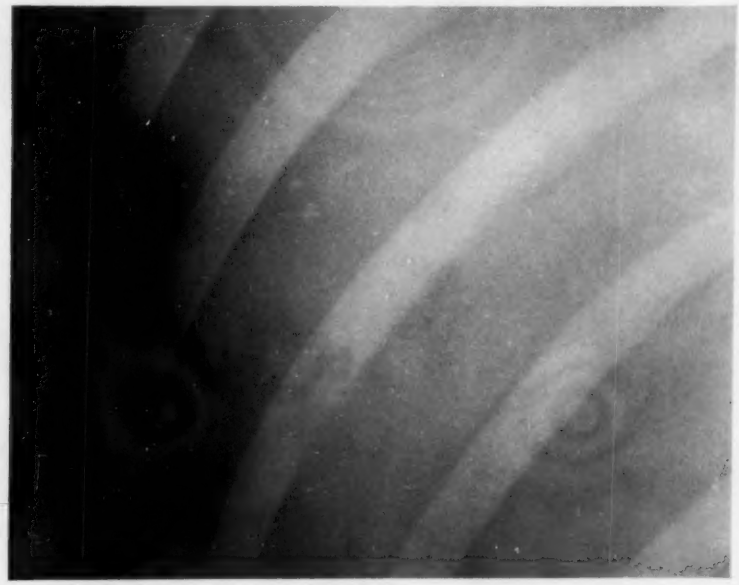

FIG. 5

Case 4—Showing destruction lesion of right tenth rib, with erosion of inferior cortex, and subperiosteal new bone formation.

Case 5—A boy, aged seven years, complained of pain in his left thigh of five weeks' duration, and had developed a limp. *On examination*, there was a slight flexion deformity of the left hip, and rotation movements were slightly limited by protective muscle spasm. The muscles of the left buttock and thigh showed slight wasting. The wing of the left ilium was tender on palpation.

Radiographs (Fig. 6) showed an irregular area of bone destruction in the left ilium, extending down to the acetabular margin. General osteoporosis of the upper end of the left femur was present, but the hip joint itself was not directly involved.

Investigations—Apart from a raised erythrocyte sedimentation rate (55 millimetres in the first hour) routine laboratory tests, including the differential white cell count, were normal.

A biopsy was done. The differential diagnosis lay between tuberculous osteitis and a primary or secondary neoplasm.

Operation—The outer table of the left ilium was exposed. It was found to be intact but soft and compressible over the lesion. A cortical window was removed immediately above the acetabulum, and a large cavity exposed containing gelatinous material. The cavity was cleared, and a specimen sent for histological examination and culture.

Histology—The appearances were those of an eosinophilic granuloma. *Culture* was sterile.

FIG. 6
Case 5—Showing irregular area of bone destruction in left ilium, with osteoporosis of upper end of femur.

FIG. 7
Case 5—Two years later. The iliac lesion has healed, leaving only a small residual defect.

FIG. 8
Case 6—Showing destructive lesion in upper part of left acetabulum, with osteoporosis of bones around the hip joint.

FIG. 9
Case 6—Fifteen weeks later, the lesion has recalcified, leaving a small defect above the acetabulum, and soft-tissue ossification.

Progress—The post-operative course was uneventful. A course of deep x-ray therapy was given. The patient's pain was rapidly relieved and movements of the left hip returned to normal. Serial radiographs showed progressive recalcification of the iliac lesion. Two years later the patient remained free from symptoms, and at that time radiographs showed only a small residual defect above the left acetabulum (Fig. 7).

Case 6—A girl, aged six years, complained of pain in her left thigh of twelve days' duration, and had developed a limp two days before attending hospital. *On examination*, all movements of the left hip were slightly limited.
Radiographs (Fig. 8) showed a small area of bone destruction in the left ilium, related to the upper part of the acetabulum. There was some general osteoporosis of the bones around the left hip.
Investigations—Routine laboratory tests, including the differential white cell count, were normal.

FIG. 10
Case 7—Destructive lesion in centre of femoral shaft, with surrounding subperiosteal new bone formation, laid down in " onion-skin " layers.

A biopsy was done. The pre-operative diagnosis was that of a tuberculous infection of the left hip joint.
Operation—The superior aspect of the left hip was exposed through an anterior Smith-Petersen incision. A superficial cystic area which contained glairy fluid was found in the roof of the acetabulum, and deep to this was a cavity about an inch in diameter, containing reddish-grey vascular material. The cavity was curetted, and the incision closed. A specimen was sent for histological examination.
Histology—The appearances were those of an eosinophilic granuloma.
Progress—After the biopsy operation skin traction was applied to the left lower limb for four weeks, and the patient was kept in bed for a further five weeks, before weight bearing was allowed. When last examined, fifteen weeks after operation, the child remained free from symptoms, movements of her left hip were normal and she walked without a limp. Radiographs then showed recalcification of the left iliac lesion with a small residual defect and two " stalactites " of soft-tissue ossification (Fig. 9).

Case 7—A girl, aged fifteen months, who had first walked at thirteen months, was observed by her parents to be limping. They attributed this to a fall one week prior to attending hospital. *On examination*, the only abnormal finding was a diffuse, slightly tender thickening of the left femoral shaft.

Radiographs (Fig. 10) showed a destructive lesion in the centre of the left femoral shaft, surrounded by a considerable amount of subperiosteal new bone formation, laid down in " onion-skin " layers.
Investigations—Routine laboratory tests, including erythrocyte sedimentation rate and differential white cell count, were normal.

A biopsy was done. A pre-operative diagnosis of Ewing's tumour was favoured, but the possibility of an eosinophilic granuloma was considered.
Operation—The affected part of the left femoral shaft was exposed. A cortical window was removed, exposing a cavity which contained yellowish gelatinous material. The cavity was cleared, and a specimen sent for histological examination and culture.
Histology—The appearances were those of an eosinophilic granuloma. *Culture* was sterile.
Progress—The left lower limb was not splinted. Eight days after the operation the child stood up in her cot and sustained a fracture through the diseased area of the femoral shaft (Fig. 11). The limb was immobilised on a Thomas's splint with fixed skin traction. The fracture united rapidly with

FIG. 11 FIG. 12

Case 7. Figure 11—Fracture after biopsy operation. Figure 12—Six months later the fracture is soundly united. Partial recalcification of the original lesion has occurred, but an area of osteoporosis has appeared in the distal portion of the shaft.

abundant callus formation. Two months later weight bearing was allowed. When last reviewed, six months after the fracture, the child remained well and was walking normally. The radiographs (Fig. 12) showed sound union of the fracture; partial recalcification of the original lesion had occurred, but an area of osteoporosis was now present in the distal part of the shaft, requiring continued observation.

Case 8—A boy, aged nine years, who was a mental defective, complained of pain in his right axillary region of two months' duration. For three weeks before examination his parents had noticed increasing weakness of his right hand. *On examination*, there was profound weakness of the movements of the right hand and wrist. The right triceps jerk was absent. Owing to the patient's mental condition it was not possible to assess sensation. Examination of the remainder of the central nervous system was otherwise normal. There was a small cervico-thoracic kyphos, and forward flexion of the cervical spine was limited by pain and muscle spasm.
Radiographs (Fig. 13) showed a destructive lesion involving the right lamina and transverse process of the first thoracic vertebra. The lateral tomograph (Fig. 14) showed collapse of the body of the vertebra.

FIG. 13

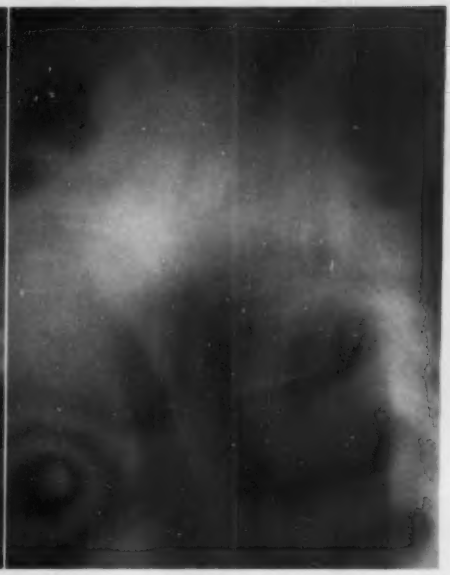

FIG. 14

Case 8. Figure 13—Showing destructive lesion of the right lamina and transverse process of first thoracic vertebra. Figure 14—Lateral tomograph, showing collapse of the body of T.1.

FIG. 15

Case 8—Eight months later, resolution is complete.

Investigations—Lumbar puncture produced a slightly turbid yellow fluid containing: protein 150 milligrams per 100 millilitres; cells 3 red blood corpuscles per cubic millimetre, 2 lymphocytes per cubic millimetre. *Culture* was sterile. The remaining laboratory tests, including the white cell count, were normal.

A biopsy was done. The pre-operative diagnosis was that of a malignant neoplasm.

Operation—The right lamina of the first thoracic vertebra was exposed, and was found to be partly invested by soft, rather gelatinous material which extruded through a small defect in the cortex. Part of this material was removed for histological examination, no attempt being made to explore the extent of the lesion.

Histology—The appearances were those of an eosinophilic granuloma.

Progress—A course of deep x-ray therapy was given, the patient being kept recumbent. The power of the right upper limb muscles improved rapidly. Two months after the biopsy no residual weakness remained, and he was allowed up, wearing a plastic collar, which was worn for a further three months. Serial radiographs showed recalcification of the vertebral lesion, progressing to complete resolution (Fig. 15). At the end of a two-year follow-up there has been no recurrence, and the patient remains free from symptoms.

DISCUSSION

The etiology of eosinophilic granuloma is unknown, but it is generally supposed to be a peculiar inflammatory reaction to some agent of infection, as yet unidentified. Cultures of biopsy material in these cases were sterile, except in Case 1, but the organisms isolated in this one instance were almost certainly contaminants.

The age incidence is in accordance with that quoted by previous writers; the condition is most frequently encountered in children and young adults. Although the sex incidence in this small series is equal, Dundon *et al.* (1946) have noted a preponderance in males, their estimated ratio being five males to one female.

Any bone proximal to the wrist and ankle may be the site of an eosinophilic granuloma, but the skull, ribs, femur, vertebrae, pelvis, mandible, humerus, and clavicles are most commonly affected. In the case of the long bones the lesion is usually, though not necessarily, situated in the shaft.

Pathology—The macroscopic appearances are those of a brownish, yellow material of the consistency of porridge, occupying the medullary cavity. The cortex of the affected bone may be thinned, eroded through, or thickened by reactive subperiosteal new bone formation. The overlying periosteum is closely adherent to the bone, or it may be perforated.

Histologically seven of these cases presented the main features of eosinophilic granuloma which, as summarised by Jaffe and Lichtenstein (1944), include: 1) Sheet-like formations of histiocytes (" the basic component "). 2) More or less conspicuous numbers of eosinophilic cells, especially of eosinophilic leucocytes. 3) Actively phagocytic multinuclear giant cells. The photomicrograph in Case 7 (Fig. 16) illustrates these appearances.

In Case 3, eosinophilic cells were a less conspicuous feature, but their presence in focal collections against a background of fibroblasts and pale-staining cells with abundant vacuolated cytoplasm was sufficiently diagnostic to place the case in the eosinophilic granuloma group.

Jaffe and Lichtenstein demonstrated that complete and spontaneous resolution can occur directly from the stage described above, but Green and Farber (1942) suggested that resolution might also occur through a subsequent and intermediate stage, in which the histological picture changes to that of a lipogranuloma, reminiscent of a Hand-Schüller-Christian lesion. In the latter, large vacuolated mononuclear cells predominate, eosinophils disappear, and the ingrowth of connective tissue is evident. The microscopic appearances in Case 3, indeed, suggest such an intermediate stage.

Clinical features—Eosinophilic granuloma may be a completely silent lesion. In three of the eight cases here described, symptoms were first noticed after an injury.

In none of the cases was there any significant systemic disturbance.

The presenting symptoms and signs of the solitary lesion are generally local pain and swelling in the case of the long bones. The severity of the pain varies, but is not usually considerable. In other sites attention may be first drawn to the condition by involvement of a related structure.

Laboratory investigations—Routine laboratory investigations do not help diagnosis, being normal in most cases.

Occasionally leucocytosis is encountered (as in Case 1), and the erythrocyte sedimentation rate may be raised (as in Case 5). Eosinophilia (4 to 11 per cent) has been recorded as an occasional finding (Dundon *et al.* 1946) but was not found in the present cases. Several writers have noted an increased serum alkaline phosphatase, as found in Case 1.

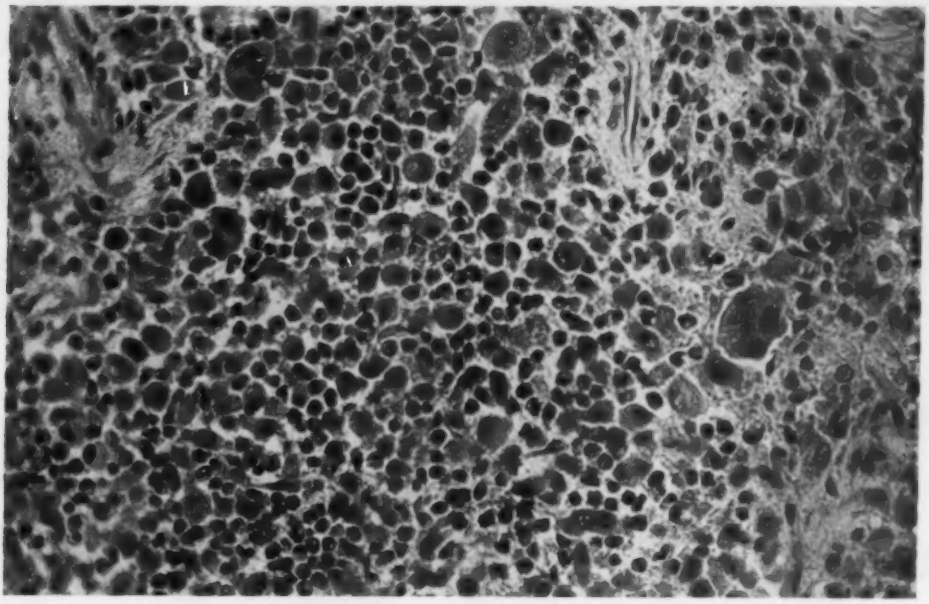

FIG. 16

Photomicrograph in Case 7, showing basic pattern of large mononuclear cells, interspersed with large numbers of eosinophilic leucocytes, and several multinuclear giant cells. (Haematoxylin and eosin, ×400.)

The cerebrospinal fluid in Case 8 showed a raised protein content, but no increase in its cellular constituents. This resulted presumably from the obstruction of cerebrospinal fluid pathways.

In Hill's (1949) case it was possible to establish a diagnosis by aspiration of the fluctuant swelling over a skull lesion: the cellular constituents of the serous fluid withdrawn contained 56 per cent of eosinophils.

Radiographic features—The lesion presents as an area of endosteal destruction, irregular in outline, or with a smooth contour producing a " punched out " effect. As it enlarges it eventually erodes the cortex, a section of which may completely or partly disappear.

Subperiosteal new bone formation is regarded by most authors as unusual. When it occurs it is said to be associated with perforation of the cortex (Fairbank 1951). Four of the present cases showed subperiosteal new bone formation. In Cases 1 and 7 it was quite a marked feature (Figs. 1 and 10). The radiographs in Case 7 in particular show well defined " onion-skin " layers resembling the classical description of Ewing's tumour. Cortical

perforation into the overlying soft tissues was observed at operation in only one of these cases, but all four showed radiographic evidence of complete destruction of parts of the original cortex.

The lesion is said to cause cortical expansion in some cases, and it may also appear loculated (Hill 1949), but neither of these features was evident in the cases here described.

The radiographic appearances of eosinophilic granuloma may be confused with a variety of other conditions, including pyogenic, syphilitic and tuberculous osteomyelitis, Hand-Schüller-Christian disease, osteitis fibrosa cystica, osteoclastoma, Ewing's tumour, osteogenic sarcoma, multiple myelomatosis, and metastatic tumours.

Complications—Pathological fractures are uncommon. Hill (1949) found only four cases in his review of the literature. The fracture occurring in Case 7 (Fig. 11) does not entirely merit such a description as it occurred soon after a biopsy operation, during which part of the femoral cortex had been removed. The rapidity with which union subsequently occurred, however, is noteworthy (Fig. 8).

The radiographs in Case 1 (Fig. 1) showed a crack fracture through the site of the clavicular lesion. This no doubt produced the first symptom of pain, and so in this instance explains the relationship of trauma to the onset of symptoms.

The involvement of the nerve roots in Case 8, with profound motor weakness, is of interest chiefly because of the rapidity with which complete recovery of the paresis occurred after radiotherapy to the first thoracic vertebra. That the latter was extensively involved is demonstrated by the radiographs (Figs. 13 and 14), which showed collapse of the body in addition to destructive changes in the right lamina and transverse process. In view of the rapid disappearance of the paresis it seems likely that the actual mode of involvement of the nerve roots was by local pressure and oedema associated with the presence of granulation tissue in the extradural space.

Green and Farber (1942) described a case of eosinophilic granuloma of a vertebra in which radiographs showed a related spindle-shaped soft-tissue shadow, resembling a cold abscess. This resolved completely without neurological complications.

Treatment and prognosis—There is no doubt from observations made by several writers on proved cases of eosinophilic granuloma, in which multiple foci were present, that complete and spontaneous recovery of the lesion can and does occur, with restitution of the normal radiographic appearances of the involved bone.

In view of the lack of specific diagnostic criteria short of biopsy, however, it follows that all cases of solitary eosinophilic granuloma of bone, once demonstrated radiographically, are likely to be explored. To curettage is then attributed the subsequent healing of the lesion. Diagnostic considerations and healing apart, curettage appears to fulfil an additional function in rapidly relieving the patient's symptom of pain, probably by decompression of the lesion. This was particularly noticeable in Case 3, in which the pain, being relatively acute, disappeared immediately after operation.

Since resolution may occur either spontaneously or after curettage, the place of radiotherapy in the treatment of eosinophilic granuloma is difficult to assess. It was employed originally as an empirical measure, and although most writers agree that it is successful in relieving pain, there is some doubt as to its actual effect on the pathological process. Hamilton *et al.* (1946) stated that they could find no radiographic evidence that radiotherapy altered the course of the disease. Hill (1949) concluded that the prognosis as regards spontaneous healing in the course of months was so good that it was unnecessary to employ radiotherapy as a routine measure. Dundon *et al.* (1946), however, described an eosinophilic granuloma of the sternum with an associated soft-tissue mass in the mediastinum. This lesion failed to settle after diagnostic curettage, and on three occasions recurring symptoms were relieved by radiotherapy. On each occasion the mediastinal mass, as seen in the radiographs, was observed to diminish in size after treatment.

It seems reasonable, therefore, in the solitary eosinophilic granuloma, to employ radiotherapy, not as a routine measure, but for the few cases which fail to resolve after curettage. It may also be used as an additional safeguard in cases in which rapid resolution is particularly desirable because of involvement or imminent involvement of important related structures such as nerve roots.

As already indicated, the prognosis of the solitary lesion is excellent, its benign course apparently being maintained even in the presence of such complications as those described. In the presence of multiple lesions it is agreed that the general outlook is also good, although in view of the relationship established with the more sinister conditions of Hand-Schüller-Christian disease and Letterer-Siwe disease, a more guarded prognosis may be advisable. A radiographic survey of the skeleton is, therefore, of some clinical importance when the apparently solitary lesion presents itself.

SUMMARY

1. Eight cases of solitary eosinophilic granuloma of bone are described, along with two possible complications.
2. The main pathological, clinical, and radiographic features of the condition, and its treatment, are discussed.
3. The essentially benign course of the solitary lesion, even in the presence of complications, is confirmed.

I am indebted to Mr F. W. Holdsworth, Mr R. A. King, Mr L. C. Oliver, Mr N. Roberts and Mr D. Wainwright for permission to publish cases under their care; to Dr E. A. Atkinson and Dr I. M. Larkin for their aid with the histological examination; to Dr J. M. Stewart for his advice and for interpreting the radiographs; and to Mr H. Osmond-Clarke for criticism and encouragement. My thanks are also due to Mr E. A. Sheppard of the Photographic Department, Oldchurch Hospital, for preparing the radiographic prints, and to Mr E. V. Wilmott for the photomicrograph.

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POSTERIOR DISLOCATION OF BOTH SHOULDERS

Report of a Case

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Most reports of posterior dislocation of the shoulder have referred to the difficulty of diagnosis and the confusing radiographic appearance unless a true lateral (vertical) view is taken. Many cases have not been diagnosed until several weeks have elapsed, and this delay has prejudiced successful treatment.

According to Malgaigne (1855) the first report of posterior dislocation of the shoulder was that of Sir Astley Cooper (1839), whose patient was an epileptic. Malgaigne described thirty-seven cases, three of his own and thirty-four from the literature. In 1902 Mynter reported posterior dislocation complicating epilepsy and mentioned a case he had seen some years before of double subacromial dislocation caused by muscle contraction from an overdose of camphor.

Moullin and Keith (1904) reported posterior dislocation of the shoulder occurring during a backhand stroke at tennis. Ellerbroek (1908) reported four posterior dislocations in a review of 404 dislocations of the shoulder. In 1932 Coover described posterior dislocations of both shoulders which occurred in an epileptic seizure and were not diagnosed for three weeks. Attempted manipulative reduction failed and open operation was not advised. The final function is not mentioned. Malpractice was alleged by the patient but his suit failed because the court felt that a practitioner exercising reasonable skill and diligence would not discover a condition so rare as to be a clinical curiosity.

In 1937 Thomas described seven cases of posterior dislocation, four of which were associated with fractures. In four cases the injury occurred during epileptic seizures. Even stereoscopic radiographs failed to reveal the dislocation in several cases. In four cases reduction was not carried out and new bone was deposited on the posterior aspect of the scapula opposite the head of the humerus, forming a new glenoid fossa. The functional recovery in these cases was surprisingly good.

Rendich and Poppel (1941) described a further case and they also emphasised its rarity and the difficulty in diagnosis.

Hindenach (1947) described a patient treated by a posterior bone block operation. Previously the patient had undergone a Nicola operation which was unsuccessful. Taylor and Wright (1952) described six cases, of which four were diagnosed on clinical grounds and the other two by lateral (axillary) radiographs.

In 1952 McLaughlin described twenty-two posterior dislocations encountered in 581 shoulder dislocations (3·8 per cent). In six the dislocation was recognised and reduced early, and the patients did well; but in sixteen cases the injury was missed for weeks or years, treatment became increasingly difficult and the function was correspondingly poor. Epilepsy was the commonest cause (six out of twenty-two). Of these twenty-two cases two were bilateral posterior dislocations. One had remained undiagnosed for thirty-five years. The patient was unable to elevate either arm or to rotate it laterally. The other patient, an epileptic, was severely disabled and unable to work. The bilateral lesions, at first recurrent, later became fixed. Operation was undertaken but the follow-up was too short for the result to be assessed.

CASE REPORT

A gardener aged forty-one was admitted to another hospital with a history that while stooping at work in the garden he had experienced visual hallucinations of familiar and unfamiliar scenes. These hallucinations obscured his normal vision for five minutes. After this

FIG. 1

Left shoulder before operation. Note the almost normal appearance in the antero-posterior projection and the deep notch seen in the lateral (vertical) projection.

FIG. 2

Right shoulder before operation. The appearance is like that of the left shoulder.

he suddenly became unconscious and was found in this state. After half an hour he came to and was helped to his bed. Almost immediately he noticed pain behind both shoulders and inability to use them. The patient denied ever having lost consciousness before. The neurologist who examined him nevertheless believed that the attack was epileptic in nature.

An antero-posterior radiograph of the shoulders showed no obvious abnormality. Three

weeks later an orthopaedic opinion was sought as the patient was still complaining of pain and restriction of movement in both shoulders.

On examination the right shoulder region was of normal contour but the arm was held in marked medial rotation. There was practically no gleno-humeral abduction, and flexion was limited to 30 degrees. All movements gave rise to pain. On the left side the findings were the same.

Further radiographs, including a vertical view, showed a posterior dislocation of the shoulder on each side. A notch in the head of the humerus was engaging in the posterior rim of the glenoid cavity (Figs. 1 and 2).

The patient was transferred to Heatherwood Hospital, and an attempt at closed reduction of the dislocations was made. This proved unsuccessful.

Operation—Open reduction was carried out on both sides. With the patient prone, a posterior incision was made through the deltoid muscle, splitting its fibres in the line of the incision

FIG. 3

Method of fixation after operation, used to prevent medial rotation.

to expose the infraspinatus. The infraspinatus was divided near its insertion and the joint capsule was opened. The head of the humerus was found to be lying in a false joint directly behind the glenoid fossa. There was a V-shaped groove in the head of the humerus which was engaged with the posterior rim of the glenoid fossa, thus preventing reduction. Part of the false capsule was becoming ossified. With some difficulty the head of the humerus was mobilised sufficiently to allow full reduction, but reduction was stable only when the humerus was rotated laterally. The capsule was repaired and the infraspinatus muscle sutured with overlap. The wound was closed and the arm held in lateral rotation. The findings and procedure were the same in both shoulders.

Post-operative progress—A plaster was applied to the forearms from the elbow to the wrist, and the ends of an aluminium rod were incorporated in the plasters to keep both arms rotated laterally (Fig. 3). This position was maintained for three weeks, and during this time further radiographs showed the reduction to be maintained on both sides. Thereafter all external

fixation was removed and the patient was encouraged in exercises to restore movement and muscle power. When last seen at eight months after the injury he complained of some pain in both shoulders, but he had been able to return to his former occupation. His main disability was that he could not reach the back of his neck or the small of his back. The range of movements was as follows (Figs. 4 and 5). Right shoulder: flexion 90 degrees, abduction 60 degrees, lateral rotation 0 degrees, medial rotation 15 degrees. Left shoulder: flexion 80 degrees, abduction 50 degrees, lateral rotation 0 degrees, medial rotation 15 degrees.

FIG. 4

Range of abduction (Fig. 4) and of flexion (Fig. 5) eight months after operation.

FIG. 5

These movements included scapular movement. Muscle power on both sides was good. Radiographs showed extensive soft-tissue ossification, but both shoulders have remained stable (Figs. 6 and 7).

COMMENT

There is mention in the literature of four cases of bilateral posterior dislocation of the shoulders. None of these cases was diagnosed early, and in only one case was reduction attempted and obtained by open operation. The follow-up was too short to allow final assessment. In another case the patient was severely and permanently disabled. In the other two cases the final function was not stated.

The case described here was not recognised for three weeks because vertical axillary radiographs were not taken. Closed manipulation failed, and open operation was carried out.

FIG. 6
Left shoulder eight months after operation.

FIG. 7
Right shoulder eight months after operation.

Although reduction of both shoulders was obtained and maintained, the final function eight months later was only fair because there was considerable limitation of abduction on both sides.

The rarity of the condition, the paucity of physical signs and failure to take true lateral (vertical) radiographs in all cases of shoulder injury are the main causes of late diagnosis, with the attendant difficulties of treatment and poor function. If these dislocations are diagnosed early, reduction is simple and full function should be restored.

SUMMARY

1. A case of posterior dislocation of both shoulders, in a patient believed to be epileptic, is described.
2. The difficulties of early diagnosis are discussed.

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CONGENITAL DISCOID MEDIAL SEMILUNAR CARTILAGE

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Since the original description of a dissecting-room specimen of a congenital discoid lateral cartilage by Young of Glasgow in 1889, numerous publications have appeared on the subject. The stage has now been reached when it is recognised to be fairly common. Abnormalities of the medial cartilage on the other hand are rare. In this report three examples are described.

Smillie (1948), in a contribution of twenty-nine cases of discoid lateral cartilage, reported the various lesions found in these abnormal structures and classified them as primitive, intermediate and infantile. In the primitive type the cartilage exists as a complete disc; the infantile approaches the normal but is abnormally broad. It is on the basis of this arbitrary classification that the literature is reviewed and discussed.

The first reference to an anomalous medial cartilage is that of Watson-Jones (1930), who described a ring-shaped cartilage at a meeting of the Royal Society of Medicine. The illustration however shows longitudinal striations on both central and peripheral parts of the " ring," which suggest that this specimen was probably a normal cartilage, the subject of a complete longitudinal (bucket-handle) tear with the central part displaced and altered by time and pressure. This view is supported by Elmslie's comments at the meeting.

The first record of an undisputed discoid medial cartilage is that of Cave and Staples (1941). Of the two specimens they described, one is undoubtedly discoid, with an anterior split and a notch such as is characteristic of lateral discs (Smillie 1948). This is an intermediate type of discoid cartilage. The other specimen was said to be " incompletely discoid " and to have a " bucket-handle " split. This is probably an example of the infantile type.

Dwyer and Taylor (1945) reported a discoid medial cartilage which was virtually a complete disc and, without question, of the primitive type. This specimen demonstrated the characteristic " horizontal cleavage " as described by Smillie (1948), who reported a similar specimen encountered in 1943. This exhibited cystic degeneration in addition to horizontal cleavage, almost the entire under surface being worn away.

Jeannopoulos (1950) reported the removal of discoid cartilages from the knee of a girl of ten, the medial in 1938 and the lateral in 1942. The medial cartilage was " abnormally wide, pear-shaped " and measured 5 centimetres by 2·7 centimetres by 0·8 centimetre. The upper surface showed a transverse ridge, the inferior was roughened and horizontal cleavage was present. This specimen, though not illustrated, was, from the description, probably infantile.

A case of " ring-shaped medial semilunar cartilage " was published by Basmajian (1952). The specimen was similar to that of Watson-Jones (1930) and cannot be accepted as a discoid cartilage. In the opinion of Professor R. I. Harris, who saw the specimen, which had been removed from a dissecting-room male subject, it represents an old longitudinal tear with complete displacement of the medial fragment.

De Palma (1954) described and illustrated a specimen which at the posterior horn was abnormally broad. The rest of the cartilage, however, was of normal dimensions and showed a longitudinal tear and a pedunculated tag. Though this specimen is unusual it is probably an example of the infantile type.

CASE REPORTS

Case 1—An engine driver aged forty-three complained of pain in his right knee. He gave a history of a twist of unknown direction, and one incident of instability subsequently. There was no history of locking, clicking or effusion. On examination the only abnormality to be found was a loud medial cartilage click in both knees. A precise diagnosis could not be

made and conservative measures were adopted. He continued to complain, however, and five months later he was admitted to hospital with persistent pain, insecurity and frequent clicking. At operation, two days later, a very large discoid medial cartilage was removed. The patient's recovery was uneventful and he was discharged in four weeks.

He reported again the following year complaining of medial pain in the left knee. There was no history of injury, locking, instability or swelling. He presented tenderness over the

FIG. 1

FIG. 2

Case 1. Figure 1—Discoid right medial cartilage of infantile type. Figure 2—The under surface shows a tear.

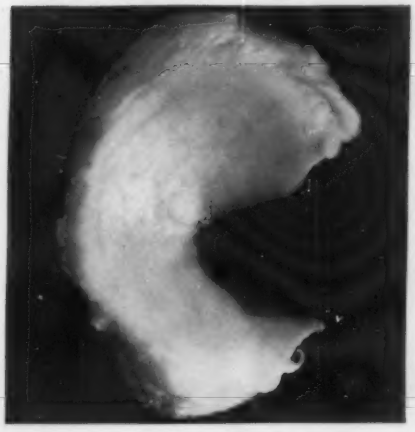

FIG. 3

FIG. 4

Case 1. Figure 3—Discoid left medial cartilage of infantile type. Figure 4—There is an early tear on the under surface.

medial joint line and a loud painful cartilage click. In view of the findings of the previous operation, operation was undertaken and again revealed an unusually large and disc-shaped medial cartilage.

The specimen removed from the right knee of this patient is abnormally broad, pear-shaped and can be classed as infantile (Fig. 1). It measured 6 by 4 by 1·3 centimetres and showed a transverse tear. It showed also the phenomenon of horizontal cleavage (Fig. 2).

The left medial cartilage followed the same pattern and measured 5·7 by 4 by 1·3 centimetres (Fig. 3). The damage to this cartilage was the same, and both horizontal cleavage and the early stage of an overt tear were evident (Fig. 4).

Case 2—A man of thirty-four, a meter inspector, had complained of recurrent pain and swelling of the right knee for seventeen years. On admission to hospital he gave a recent history of instability and frequent clicking. On examination a tender swelling on the antero-medial aspect was found and a loud medial cartilage click was elicited. At operation a large primitive discoid cartilage was removed.

The specimen measured 5·5 by 4 by 1·2 centimetres and showed horizontal cleavage. Apart from the periphery, the whole of the upper surface had been worn away (Figs. 5 and 6).

FIG. 5

FIG. 6

Case 2. Figure 5—Discoid right medial cartilage. The upper surface shows the extent of damage following horizontal cleavage. Figure 6 shows the under surface.

SUMMARY

1. The occurrence of congenital discoid medial cartilages in two patients is reported: in one the abnormality was bilateral. The three specimens are described and illustrated.
2. The literature on the subject is reviewed and the specimens discussed and classified.

I would like to thank Mr I. S. Smillie for his help and criticism.

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WEAR AND TEAR IN JOINTS

An Experimental Study

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It is generally considered that wear and tear of articular cartilage resembles that of skin, the surface layers constantly being rubbed off by friction and the original thickness of the cartilage being maintained by multiplication of the deeper cells. The processes of wear and replacement must proceed at very different rates in the two tissues, however, for not only is it extremely difficult to find products of cartilage erosion in synovial fluid (Davies, personal communication) but the ability of articular cartilage to proliferate after artificial lesions have been made within it is remarkably slight (Bauer, Ropes and Waine 1940). Moreover, whereas skin soon becomes raw and ulcerated if subjected to excessive friction, articular cartilage is unaffected by wear and tear far in excess of the normal—for instance, the joint surfaces appear quite normal in mice that have been exercised almost continuously on a treadmill for up to two years (Lanier 1946).

According to Jones (1934), dry joints are severely eroded after being exercised for only a few hours. This finding can be explained on MacConaill's hypothesis (1932) that the movement of synovial joints is assisted by fluid film lubrication, *i.e.*, that during movement there is no direct contact between one cartilage-covered surface and another, the moving parts always being separated by a wedge-shaped film of synovial fluid. In these conditions frictional resistance occurs only between successive layers of the fluid.

The present study was undertaken to determine the role of synovial fluid in preventing wear and tear of articular surfaces. It was based on the supposition that by diminishing the viscosity of the synovial fluid the mechanical efficiency of the joint would be reduced and the likelihood of attrition supervening after a short period of exercise would be correspondingly increased.

MATERIAL AND METHODS

The ankle of the rabbit was chosen as a typical weight-bearing synovial joint of the hinge variety. The viscosity of the synovial fluid was reduced by degradation of the contained hyaluronic acid, using either the specific enzyme hyaluronidase (" Hyalase," Benger Laboratories) or a vitamin C-hydrogen peroxide complex which has an action upon mucins in general (Robertson, Ropes and Bauer 1941). *In vitro* experiments by Ogston and Stanier (1953*b*) suggested that by this means the viscosity of synovial fluid might be reduced almost to that of water within two hours.

Each rabbit was killed with chloroform and the ankle joints were immediately bared down to the ligaments and capsule by making encircling skin incisions and severing all the tendons passing over the joints. The mucin-destroying agent, made up either in water or in a buffered solution at PH 6·8, was injected into one joint, the other being used as a control. An equivalent volume of water or the buffer solution was usually injected into the control ankle.

The dead rabbit was then placed on its back and its tibiae secured to a table by metal pins. Each foot was then dorsiflexed and plantarflexed at the ankle, for periods ranging from six to forty-eight hours, by means of an electric motor. The angular range of movement was set at 30 degrees. In many of the experiments, the pressure between the joint surfaces was increased by means of springs fixed at one end to the foot and at the other to hooks fitted

to the table near the rabbit's head. If the spring were attached on the plantar aspect of the body of the talus the tension within it remained at approximately 1·4 kilograms irrespective of the position of the foot (described as "constant external compression" in Table III); if attached half way between the ankle and the distal end of the foot, the tension rose to 2·5 kilograms

TABLE I

JOINTS IMMOBILE FOR THIRTY-SIX HOURS

Experiment number	Treated ankle	Macroscopic findings	Microscopic findings	Remarks
1	500 units of Hyalase in 0·05 millilitres water	Joint surfaces appear normal	Confirmed	Solutions not injurious to articular cartilage
2	0·05 millilitres of buffered ascorbic acid-peroxide solution	Joint surfaces appear normal	Confirmed	

TABLE II

JOINTS EXERCISED WITHOUT EXTERNAL COMPRESSION

Experiment number	Treated ankle	Control ankle	Duration	Range of joint movement	Macroscopic findings	Microscopic findings	Remarks
3	150 units Hyalase in 0·02 millilitres water	Untreated	6 hours	Mid-range movement	No abnormality detected	Confirmed	Even large quantity of Hyalase ineffective over short periods
4	200 units Hyalase in 0·05 millilitres water	Untreated	7 hours	Mid-range movement	No abnormality detected	Confirmed	
5	250 units Hyalase in 0·1 millilitres water	Untreated	7 hours	Plantarflexion	No abnormality detected	Confirmed	
6	500 units Hyalase in 0·05 millilitres water	Untreated	8 hours	Dorsiflexion	No abnormality detected	Confirmed	
7	500 units Hyalase in 0·05 millilitres water	Untreated	24 hours	Plantarflexion	No abnormality detected	Slight attrition in treated ankle	Attrition produced by prolonged exercise
8	500 units Hyalase in 0·05 millilitres water	Untreated	24 hours	Dorsiflexion	Excoriation of talar margins in both, especially treated ankle	Confirmed	
9	500 units Hyalase in 0·05 millilitres water	Untreated	48 hours	Dorsiflexion	Definite attrition and discoloration in treated ankle	Confirmed	

as the foot was pulled into plantarflexion and fell almost to zero when it was dorsiflexed (" intermittent compression " in Table IV). The speed of the motor was unchanged throughout: the foot performed 100 complete excursions per minute. This was considered to be a physiological rate for this particular joint, easily attained in the living animal. It was realised that heating of the surfaces was likely to result from prolonged movement at this high rate, but this factor would apply equally to both treated and control joints unless the efficiency of their lubrication differed.

Twenty-nine adult rabbits were used in these experiments. At the conclusion of the running period the joints were opened and inspected. Most were then sectioned and examined microscopically.

RESULTS

Details of the experiments performed are given in Tables I–IV. The findings may be summarised under five headings.

Time required to cause attrition lesions—Consistent damage to the articular cartilage was obtained only after twenty-four hours or more of continuous movement. When the joints were exercised for shorter periods the surfaces in the injected joint were seen to lack the lustre of the control joint and sometimes showed a fawn discoloration, presumably due to overheating, but no abnormality could be seen under the microscope.

Effect of compression of the joint surfaces—Compression was necessary to bring about severe lesions; when the springs were omitted, the wear of the surfaces was much less obvious. Intermittent compression was more destructive of the surfaces than sustained steady pressure (Figs. 1*c*, *d*, *e*, *f*).

Range of movement—When the joint was exercised through the middle part of its total range, or near the extreme of plantarflexion, wear was less noticeable than when exercised over the

TABLE III

JOINTS EXERCISED WITH CONSTANT EXTERNAL COMPRESSION

Experiment number	Treated ankle	Control ankle	Duration	Range of joint movement	Macroscopic findings	Microscopic findings	Remarks
10	500 units Hyalase in 0·03 millilitres water	0·03millilitres water	30 hours	Plantarflexion	Slight attrition of talar margins both ankles	More excoriation on treated side	Definite attrition especially when joints exercised during dorsiflexion part of their range
11	500 units Hyalase in 0·03 millilitres Ringer-Locke's solution	0·03millilitres Ringer-Locke's solution	48 hours	Plantarflexion	As above	As above	
12	500 units Hyalase in 0·03 millilitres Ringer-Locke's solution	0·03millilitres Ringer-Locke's solution	48 hours	Dorsiflexion	Definite attrition on treated side	Confirmed. Slight wear on control ankle also	
13	500 units Hyalase in 0·05 millilitres water	0·05millilitres water	48 hours	Dorsiflexion	As above	Confirmed. Control side appears normal	
14	0·05 millilitres of buffered ascorbic acid-peroxide solution	0·05millilitres of buffer only	30 hours	Plantarflexion	? Slight attrition of talar margins in treated ankle	Attrition confirmed	

last 30 degrees of dorsiflexion. This finding could presumably be correlated with the increased tension that developed in the joint ligaments as full dorsiflexion was approached, adding to the forces compressing the articular cartilage (Figs. 1*a*, *b*, *c*, *d*).

Region most affected—The central hollow on the trochlear surface of the talus was invariably unaffected, all the wear being confined to the lateral or, less commonly, the medial margins (Figs. 2*a*, *b*). For obvious reasons attrition was situated in the anterior part of the articular cartilage when the joint was exercised in full dorsiflexion.

Microscopic evidence of wear and tear—The earliest sign of attrition was the disappearance of the flattened surface layer of cartilage cells (Figs. 3*a*, *b*). Rounded cartilage cells could be seen in contact with the free surface or even projecting through it. At a more advanced stage the non-calcified zone of the articular cartilage was missing, the usual line of demarcation in sections between this and the calcified zone now forming the free border of the joint surface (Fig. 3*c*). The final stage was the erosion of the full thickness of the articular cartilage as well as the underlying bone (Fig. 3*d*).

TABLE IV

JOINTS EXERCISED WITH INTERMITTENT COMPRESSION

Experiment number	Treated ankle	Control ankle	Duration	Range of joint movement	Macroscopic findings	Microscopic findings	Remarks
15	500 units Hyalase in 0·02 millilitres Ringer-Locke's solution	0·02millilitres Ringer-Locke's solution	30 hours	Plantarflexion	Slight wear both joints, especially control side	Anomalous result confirmed	Definite attrition after exercise in dorsiflexion or plantar-flexion
16	500 units Hyalase in 0·05 millilitres Ringer-Locke's solution	0·05millilitres Ringer-Locke's solution	30 hours	Plantarflexion	Definite wear mainly on treated side	Confirmed	
17	0·05 millilitres of buffered ascorbic acid-peroxide solution	0·05millilitres of buffer only	30 hours	Plantarflexion	Marked wear and discoloration on treated side	Confirmed	
18	0·05 millilitres of buffered ascorbic acid-peroxide solution	0·05millilitres of buffer only	48 hours	Plantarflexion	Marked wear and discoloration on treated side	Confirmed	
19	500 units Hyalase in 0·03 millilitres Ringer-Locke's solution	0·03millilitres Ringer-Locke's solution	30 hours	Plantarflexion	As above	As above	
20	500 units Hyalase in 0·05 millilitres Ringer-Locke's solution	0·05millilitres Ringer-Locke's solution	48 hours	Plantarflexion	As above	As above	
21	500 units Hyalase in 0·02 millilitres Ringer-Locke's solution	0·02millilitres Ringer-Locke's solution	30 hours	Plantarflexion	Slight wear in both joints	Equal, slight wear in both joints	
22	500 units Hyalase in 0·02 millilitres Ringer-Locke's solution	0·02millilitres Ringer-Locke's solution	30 hours	Dorsiflexion	Definite wear on treated side	Confirmed; slight wear control side also	
23	500 units Hyalase in 0·02 millilitres Ringer-Locke's solution	0·02millilitres Ringer-Locke's solution	30 hours	Dorsiflexion	Definite wear especially on treated side	Confirmed	
24	500 units Hyalase in 0·05 millilitres Ringer-Locke's solution	0·05millilitres Ringer-Locke's solution	30 hours	Dorsiflexion	As above	As above	
25	500 units Hyalase in 0·05 millilitres Ringer-Locke's solution	0·05millilitres Ringer-Locke's solution	30 hours	Dorsiflexion	As above	As above	
26	0·05 millilitres of buffered ascorbic acid-peroxide solution	0·05millilitres of buffer only	48 hours	Dorsiflexion	As above	As above	
27	0·03 millilitres of buffered ascorbic acid-peroxide solution	0·03millilitres of buffer only	48 hours	Dorsiflexion	As above	No sections cut	
28	0·03 millilitres of buffered ascorbic acid-peroxide solution	0·03millilitres of buffer only	48 hours	Dorsiflexion	As above	As above	
29	0·03 millilitres of buffered ascorbic acid-peroxide solution	0·03millilitres of buffer only	48 hours	Dorsiflexion	As above	As above	

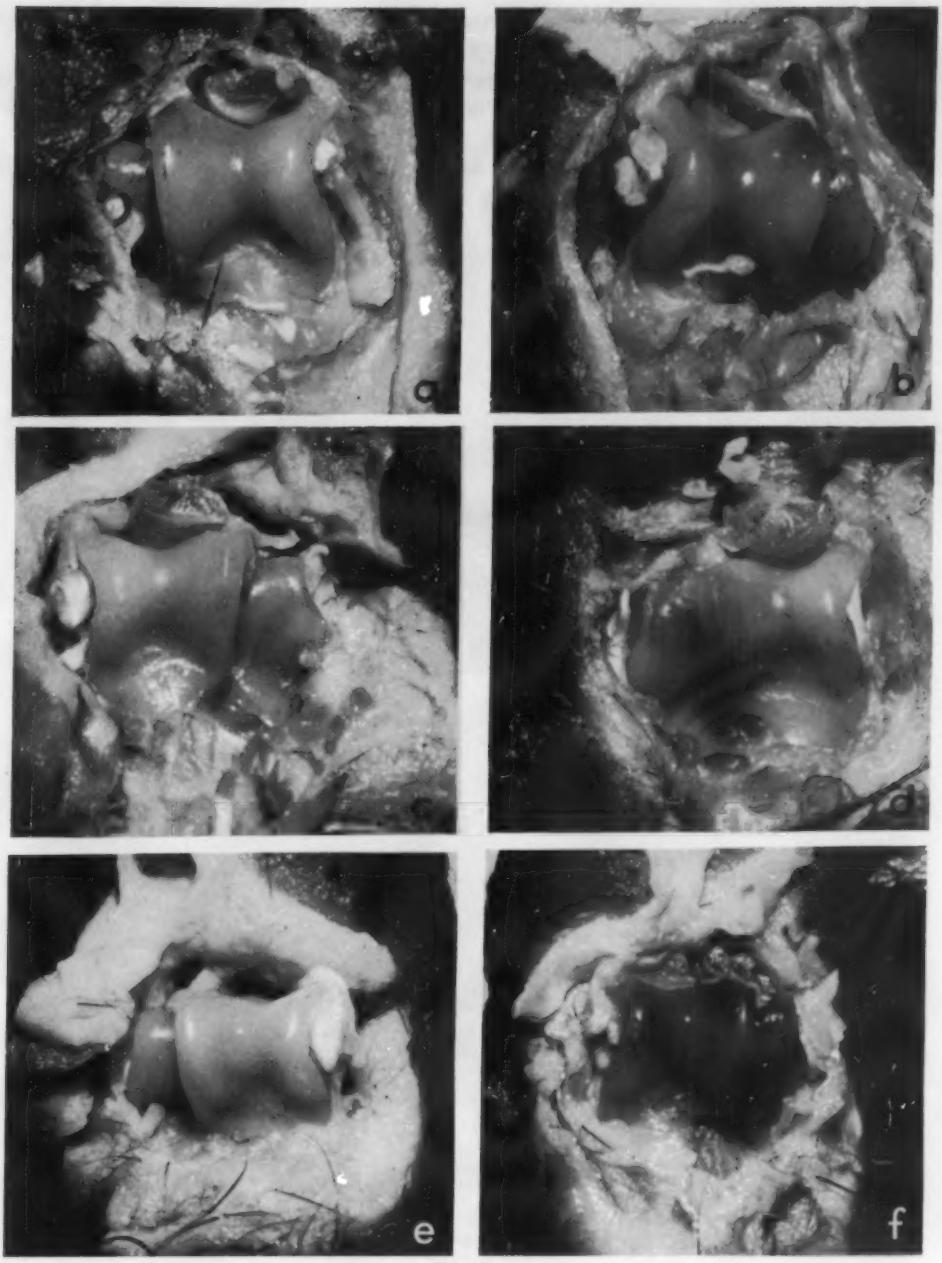

FIG. 1

Three pairs of rabbit tali photographed under identical conditions. (×4.) (*a*) Talus from control joint exercised in plantarflexion for forty-eight hours, with sustained pressure. Slight roughening of left margin posteriorly. (*b*) Contralateral talus, treated with Hyalase. Discoloration and slight roughening of articular surface. (*c*) Talus from control joint exercised in dorsiflexion for forty-eight hours, with sustained pressure. No macroscopic attrition. (*d*) Contralateral talus, treated with Hyalase. Discoloration and roughening of articular surface, especially anteriorly. (*e*) Talus from control joint exercised in dorsiflexion for forty-eight hours, with intermittent pressure. No macroscopic attrition. (*f*) Contralateral talus, treated with ascorbic acid-hydrogen peroxide solution. Marked discoloration and roughening of articular surface, especially anteriorly.

DISCUSSION

Reduction of the viscosity of the synovial fluid within a joint is evidently a convenient method of accelerating wear and tear of the articular surfaces. This finding constitutes indirect confirmation of MacConaill's view that fluid film lubrication is of importance in articular mechanics.

It is understandable that synovial fluid can act as an efficient lubricant in joints that carry light loads and move rapidly because these are the two conditions that make for

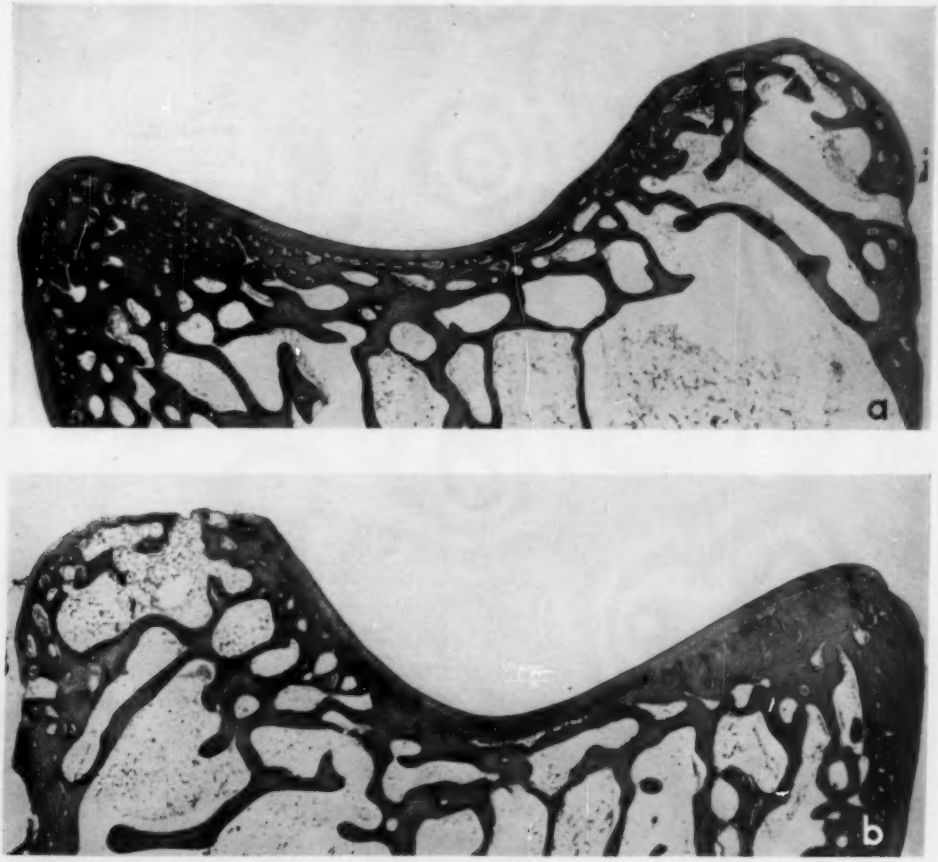

FIG. 2

Comparable sections through control (*a*) and Hyaline-treated (*b*) joints, showing erosion of lateral talar margin in (*b*). (Haematoxylin and eosin, ×18.)

satisfactory film lubrication (Reynolds 1886). Charnley (1954) pointed out, however, that this type of lubrication is difficult to achieve between two surfaces that are forcibly compressed together and are moving only slowly relative to one another, and for this reason he believed that the smooth gliding of one articular surface upon another did not depend on the maintenance of a fluid film between them.

It is probable that recent work in other fields may resolve this difficulty. Colloidal dispersions of large, irregular or long-chain molecules behave differently from pure oils of a relatively simple structure. In particular, their effective viscosity rises markedly when the

rate of shear decreases; in other words, they behave as very thick oils when movement between the surfaces is slow and thus the viscous film is less likely to break down. Ogston and Stanier (1953*a*) demonstrated that hyaluronic acid molecules confer this property upon synovial fluid. Slowly moving joints are therefore adequately lubricated.

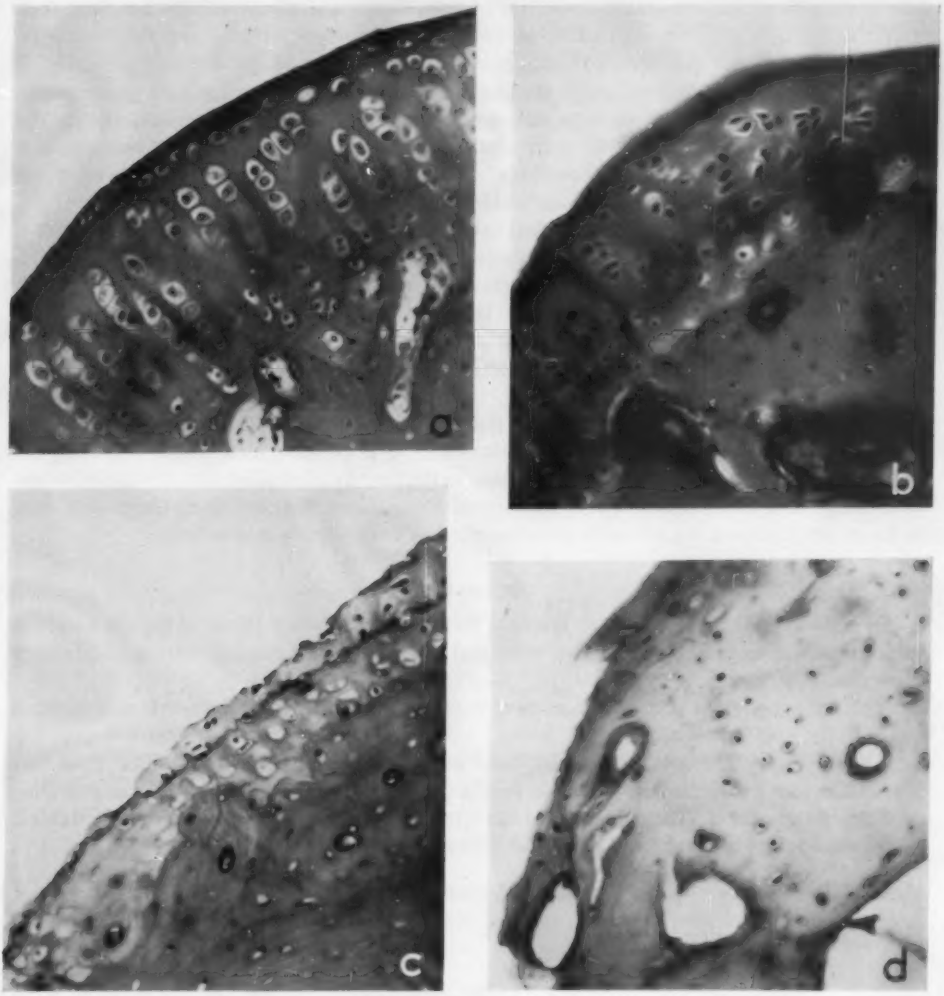

FIG. 3

Four stages of wear and tear of articular cartilage. (Haematoxylin and eosin, ×260.) (*a*) Control talus after forty-eight hours' exercise in plantarflexion. Rounded cells near surface, otherwise normal appearance. (*b*) Hyalase-treated talus after thirty hours' exercise in plantarflexion. Fluffy articular surface with protruding cartilage cells. (*c*) Hyalase-treated talus after forty-eight hours' exercise in dorsiflexion. Much of the non-calcified layer of articular cartilage has been shed. (*d*) Hyalase-treated talus after forty-eight hours' exercise in dorsiflexion. Full thickness of articular cartilage as well as underlying bone eroded.

An even more important experimental finding is that thin films of synovial fluid are remarkably resistant to static compression. Ogston and Stanier (1953*a*) calculated that a compressing force of 10–100 kilograms per square centimetre was insufficient to squeeze synovial fluid from between two plates. In the human body the joint that has to sustain the

greatest pressure is probably that between the first metatarsal and its sesamoid bones. It can be shown, using a plastic pedograph (Barnett 1954), that as the heel is rising from the ground the pressure at this joint may rise to 40 kilograms per square centimetre. Even here, then, the fluid film would normally be maintained between the articular surfaces, but it is probably significant that the upper aspect of these sesamoids nearly always shows attrition lesions in elderly dissecting-room subjects (unpublished observations). It is noteworthy, however, that even if the critical pressure is exceeded at any joint the amount of wear and tear would be less than between two unlubricated metal plates. The elasticity of the non-calcified layer of articular cartilage must help to reduce the likelihood of attrition, for any minute prominences on one surface are less likely to score the opposing surface than if both are incompressible. Brazier and Holland-Bowyer (1937) attributed the efficiency of rubber-covered bearings to a similar cause; these bearings are exceptionally resistant to abrasion even if the lubricant has a lower viscosity than is theoretically desirable, provided overheating is prevented.

Finally, it must be borne in mind that articular cartilage behaves in some respects like a sponge, being capable of imbibing or releasing synovial fluid (Ekholm and Norbäck 1951). Joint surfaces can thus be likened to sheets of sintered copper (a sponge-like preparation of the metal) impregnated with one of the new long-chain plastic materials such as polytetrafluoroethylene. Bowden (1955) showed that such surfaces were remarkably slippery and had a coefficient of friction far less than that of metal surfaces smeared with conventional lubricants.

The present experiments demonstrate that even in unfavourable circumstances articular surfaces are very resistant to wear and tear, and it is possible that under physiological conditions there is so little loss of surface tissues in the healthy adult joint that no multiplication of cartilage cells need occur. The conventional comparison of articular cartilage with skin, so far as attrition and regeneration are concerned, is undoubtedly misleading.

SUMMARY

1. By reducing the viscosity of the synovial fluid within the ankle joints of rabbits and then subjecting these to prolonged exercise, wear and tear of articular cartilage can be consistently produced.

2. This finding is an indirect confirmation of the view that fluid film lubrication is an important factor in the mechanical efficiency of joints.

3. The special properties of synovial fluid and articular cartilage that allow fluid film lubrication to exist within joints that are, in effect, slowly moving, heavily loaded, reciprocating bearings are discussed. They account for the remarkable resistance to wear and tear exhibited by synovial joints under physiological conditions.

The helpful advice and criticism of Professor D. V. Davies is gratefully acknowledged.

Since this paper was written an International Unit of hyaluronidase has been defined: 1500 International Units are equivalent to 1000 Benger Units.

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ALBIN LAMBOTTE

1866-1955

The beloved Maître of Belgian surgery and great pioneer of internal fixation for fractures passed away in Antwerp at the age of ninety on August 1, 1955. His death has provoked world-wide expressions of affection and esteem.

Dr Albin Lambotte was born near Brussels on July 3, 1866, the youngest of a family of nine. In due course he qualified with distinction from the Université Libre, and the same year obtained the post of *interne* at the Stuyvenberg Hospital in Antwerp, the city he was to make his home for the rest of his life. In 1894, only three years after leaving his medical school, he successfully performed his first gastrectomy and embarked on the outstanding career in major surgery which soon established his European reputation and eventually brought him high honours from many learned societies. From about 1902, the year he produced his remarkable *fixateur externe*, Lambotte concentrated his attention on the treatment of fractures, and a record of his early enterprise in this field may be found in his book *L'Intervention opératoire dans les fractures*, published in 1907. Fascinated by the problems of exact reduction and firm fixation, he proceeded to design a number of special instruments, many of which, and particularly his bone-holding clamps, had such a fitness for their purpose that they have remained almost unchanged. Lambotte, himself a skilled craftsman, used to make accurate models, often in wood, for the manufacturers to work from; the examples he kept scattered about his large workshop were of great historical interest and will surely be preserved.

Much of Lambotte's early work was contemporary with that of Arbuthnot Lane, but it proceeded along different lines and was almost certainly independent. At the time Lambotte was probably not more than just aware of events in London—French was his language and he always turned to France. That he came to admire Lane's work is evident from these words—"A Monsieur le Docteur Arbuthnot Lane, en témoignage de grande admiration"—which he wrote in a copy of his second book, *La chirurgie opératoire des fractures*, published in Paris in 1913, and now in the Library of the Royal Society of Medicine. In his later years Lambotte gradually retired into his sunlit workshop with its orderly array of tools and its walls hung with stringed instruments of his own making. A visit to his home was like a pilgrimage.

Over the years of his active life Lambotte taught many pupils, who were devoted to him not only for his qualities as a surgeon but for the breadth of his intellectual interests. Lambotte was in fact one of those rare men who can make a success of anything they choose to turn their hands to. Not only was he an accomplished violinist but he made violins, violas

The first occasion upon which Lambotte used his *fixateur externe*. (Reproduced by kind permission of Messrs Masson et Cie.)

and 'cellos of superb quality. Well read and widely travelled, he became a connoisseur of art, and his own sculptures in wood were quite delightful. Then he could turn his hand to any kind of mechanical problem and would make for example a fishing reel or rod of superb design, or repair the watches of his nursing sisters.

Those who attended the Bristol meeting of the British Orthopaedic Association will remember the warmth with which Jean Verbrugge, Lambotte's senior pupil, friend and historian, spoke of his old master and may wish to refer to his extended appreciation in the October number of Acta Orthopaedica Belgica. The work of Lambotte lives on in the vigorous Société Belge d'Orthopédie which he helped to found and never ceased to inspire. K. I. N.

Dr Walter Dauw of Antwerp writes: Dr Albin Lambotte was a great genius and notwithstanding the honours bestowed upon him he remained a simple, warm-hearted and generous man, always ready to assist and give advice to his colleagues, who had the greatest admiration for his skill and regarded him as their great Master. During the years that I was his assistant I had every opportunity to appreciate fully his enthusiasm for osteosynthesis. He will remain in the memory of all those who knew him closely as a well-doer to mankind.

ARTHUR VINCENT MEEHAN

1890-1955

The distinguished Queensland orthopaedic surgeon, Arthur Vincent Meehan, died suddenly in his consulting suite at Ballow Chambers, Wickham Terrace, Brisbane, on December 1, 1955, at the age of sixty-five years. Educated at St Joseph's College, Lewisham, Sydney, he graduated M.B. at Sydney University in 1914. He served thereupon as Resident Medical Officer at Sydney Hospital and was acting superintendent when, in 1915, he enlisted in the Australian Imperial Force, joining the 9th Field Ambulance as Captain. He had a distinguished war record, attaining the rank of Lieutenant-Colonel, twice being mentioned in dispatches. He was wounded at Paschendale and his right leg was amputated below the knee. Although over the years the stump was bothersome it proved no brake on his manifold surgical and academic activities and he was an exemplar of successful adaptation to a prosthesis. On discharge from the Army in 1918 he and a small group of Australian medical men worked under the tutelage of Robert Jones and McMurray in Liverpool where they were saturated with the Liverpool Thomas-Jones principles. Subsequently Meehan went to Edinburgh to complete his foundation training by gaining the Fellowship in Surgery in 1919. On returning to Australia in the same year he married Miss Marian Kenny and

practised in the new speciality of orthopaedic surgery in Brisbane, Queensland. He was appointed to the Rosemount Repatriation Hospital and then to the Hospital for Sick Children (1920–31). He was honorary orthopaedic surgeon to the Brisbane Hospital from 1922 to 1928, and joined the staff of Mater Public Hospitals in 1931, retiring from the active staff in 1950 but remaining consultant surgeon till his death. He served throughout the second world war as orthopaedic surgeon to the 112 A.G.H. Brisbane, and was Consultant to the Army and Air Force. He thus started and organised all the orthopaedic clinics in Brisbane and with ardent spirit and enthusiasm passed the Liverpool torch on to his colleagues who are now senior surgeons in this city, ready as they were to accept an overseas surgical culture.

Arthur Meehan was a prominent Rotarian, serving as President of the Queensland Branch for a term. At his death he was chairman of the Queensland Post-Graduate Medical Education Committee which office he held for some years. He was a foundation fellow of the Royal Australian College of Surgery and State Chairman; and he was a foundation member of the Australian Orthopaedic Association and president from 1942 to 1944. He was a Fellow of the British Orthopaedic Association. He was a vigorous and active member of the British Editorial Board of the *Journal of Bone and Joint Surgery*. As director of the Queensland Crippled Children's Society he was responsible for much of the important work done for cripples in this state. He also took a prominent part in the organisation of the Mater Hospital teaching school where his facile imparting of deep surgical knowledge won for him a deservedly high reputation. His surgical influence in this state is unequalled. Progressively conservative, he spoke infrequently but always revealingly and to the point. His disapproval of surgical immaturity, as shown by contributions to surgical meetings, was usually expressed only by silence.

Historically, Australia's first orthopaedic surgeons were Teece and Glisson of Sydney, Betts of Adelaide, and Meehan of Brisbane. There are now over eighty active orthopaedic surgeons in this country. Avalanches of cripples well-nigh overwhelmed those pioneers. Arthur Meehan often said that seldom did a week pass without his seeing a paralytic quadruped. The Australian Massage Association had not long been formed, and young orthopaedic surgeons had to formulate and direct a suitable training for aspirants to this profession. The newer treatments of the injured, the Thomas principles and their enlargement by Robert Jones, still had to be learned here by surgery and its handmaid.

Meehan was a skilled operator. His bloodless, cautious and gentle technique set a standard which associates find difficult to imitate. He was an ardent exponent of the non-touch technique of surgery. From the time that he arrived here a complete reorganisation of theatre techniques and fashions arose. For those willing to learn the new orthopaedic message he held night classes at the hospital. Storms of irritability were not infrequent in this stage of transition; but he achieved victory by establishing firmly a more modern theatre mode. His practising pupils to-day, perhaps not over-impressed by more enticing operative possibilities under antibiotic umbrellas, work rather under the fear of chronic invalidism from bone sepsis. He early appreciated the risks of operating through old septic and fibrous scars; he excised them before doing later surgery. He never became converted to the closing of wounds after excision in compound fractures. In earlier years he practised Stoeffel's operating techniques for the relief of spastic muscle imbalance but, being disappointed with the results, favoured arthrodesis especially in the wrist. Likewise in the treatment of talipes equino-varus he abandoned Ober's operation and the more radical one of Brockman because follow-up revealed few satisfactory results. Similarly the decancellation operation of Ogsden, and of Curtis and Muro, was condemned after trial. His demonstration of the Naughton-Dunn operation to a meeting of the Royal Australasian College of Surgeons in Brisbane in 1935 was hailed as a masterpiece. All fractured femora in children, and most of these fractures in adults, were treated with the Thomas splint. He

pioneered the Bankart operation in Australia and adhered to the original difficult technique of refixing the glenoid labrum to the bone, believing that the Putti-Platt variation was a schismatic departure from a fundamental attack—an unsound compromise. He never regretted his sparse experience in disc surgery, regarding the operation as neurosurgical. He was wont to say that whoever practised it would not gain much credit. His early experiences with spinal fusion for low back insufficiency made his approach to this problem conservative indeed, and he demanded the strictest indications, even in spondylolisthesis. He had his own unfailing method of arthrodesing the knee with parallel twin cortical grafts transfixing both condyles. For congenital dislocation of the hip if surgical intervention was needed at all he practised only the Colonna operation, though sometimes in adults a bifurcation osteotomy. He never practised acrylic prosthetic hip arthroplasty either for arthritis or for ununited fracture of the neck of the femur, but he did do cup arthroplasty for bilateral osteoarthritis of the hips. At the 1955 meeting of the Australian Orthopaedic Association in Sydney he presented the detailed results of fifty-six followed-up cases of subcervical push-in abduction osteotomy.

The State, the sick, and countless friends have sustained an irreparable loss.

R. S. L.

Having had the rare privilege when visiting Australia of meeting Arthur Meehan, enjoying the hospitality of his wonderfully happy home, and corresponding with him ever since, I must say a word about this quiet, shrewd and lovable man. When I met him he was President of the Australian Orthopaedic Association, and had long been the father of orthopaedics in Queensland. He was a great man, wholly without pride or pretension, at peace with himself and with his fellows. He was filled with a quiet sense of humour. He knew his fellow men and loved them as much for their faults as for their graces. It is given to few to inspire disciples; Meehan has done so, and his memorial is in the hearts and minds of the followers to whom he has handed the torch of orthopaedics in Queensland. H. J. B.

ANDREW RUSSELL MURRAY

1910-1955

Andrew Russell Murray was born in Tasmania and was educated in Melbourne at Scotch College and at Ormond College in the University of Melbourne, where he graduated M.B., B.S., in 1936. His university career, if not particularly distinguished academically, was a full one. Loss of one leg and paralysis of an ulnar nerve from childhood accidents did not prevent him from taking part in the general run of extracurricular activities. He was for instance an accomplished cricketer and ballroom dancer, and in his senior years he was on the College Committee—a position of some honour.

During resident years at the Alfred Hospital he found his bent and he went from there to London and then to Edinburgh, where in due course he gained the Fellowship of the Royal College of Surgeons. Having been rejected for military service he held appointments over the war years at the Edinburgh Royal Infirmary where he was temporary assistant surgeon, and at Leith, working mainly in general surgery but tending to orthopaedics and in particular to the surgery of the hand. At the end of the war he worked in the Accident Service of the Oldham Infirmary, Lancashire, and then returned to Brisbane in 1948.

Brisbane and Murray suited each other very well. Murray needed scope, and Brisbane gave him that in full measure. In return Murray brought a great ability, well trained in a good school, and in particular an exceptional skill in hand surgery and an enthusiasm for investigation. He brought the vision of a complete accident and rehabilitation service which he pressed with great vigour. This was of course a long-term project but some results were already apparent. Much of the credit for the recently established school for occupational therapists in the University of Queensland is attributable to his effort.

Murray was at his best as a clinical investigator. Thoughtfully planned, meticulously executed and carefully annotated, his investigations served as models. In so short a time at the Brisbane Hospital he completed important investigations on hand sepsis, lumbar disc lesions, the repair of the paralysed hand, and the scope of radial styloidectomy. At the time of his death he was studying the carpal tunnel syndrome and lesions of the cervical discs. He devised a most ingenious operation for opponens palsy. He was an excellent operator—quick, deft and exact. Diligent practice of trick movements had overcome the handicap in his left hand.

Murray was of a breed that thrives on difficulties. His physical handicaps and earlier professional disappointments on the one hand, and his sturdy almost fierce independence on the other, combined to produce the burning desire to excel that was perhaps his most dominant characteristic. The desire was apparent only in the way he drove himself. Indeed his capacity for work was extraordinary. Of rather spare physique, with austere and even gaunt features, he had a warm personality, a dry wit and leavening of humour, a kindness and understanding, with great loyalty. In his colleagues he commanded feelings of deep affection and trust; in his patients a blind unquestioning faith; and amongst his juniors something near to hero-worship. His loss to this state, to his patients, to his many friends, to the team at the Brisbane Hospital of which he was so vital a member, and perhaps to surgery as a whole is incalculable. He leaves a wife and three very young children. D. W.

WILLIAM MACKENZIE
1878-1955

Dr William Mackenzie came to Newcastle in 1907 sufficiently well qualified for the life of a consultant, but instead he chose to enter private practice in Gosforth. He resigned a surgical appointment at the Sick Children's Hospital in 1911 when he became the visiting Medical Officer to the Gosforth Home for Crippled Children, seeing in this sphere a greater opportunity. His first annual report startled the committee of the Home by the revolutionary proposal that some of the children would benefit by orthopaedic treatment. Military service abroad in 1915 interrupted his schemes, but secondment after sick leave to the Northumberland War Hospital at Gosforth enabled him to make progress through the powerful support of Rutherford Morison and of Robert Jones. A year at Alder Hey gave him active orthopaedic experience and on his return the Committee agreed to the erection of the hospital unit which Sir Robert Jones opened in 1924. Morison guided the venture and Mackenzie welcomed the cooperation of various physicians and surgeons, taking upon himself all the additional hospital responsibilities.

His next objective was the establishment of orthopaedic clinics for infants and school children in Newcastle and in Northumberland. Administrative and other difficulties were overcome by personal appointments in Newcastle in 1923 and in Northumberland in 1928. Mackenzie thus became the central link in an orthopaedic scheme, though it was ten years before it was officially recognised as such, and the advent of the second world war postponed his acceptance of a full-time post.

These war years were difficult ones for Mackenzie, because the Sanderson Orthopaedic Hospital School, as it was now called, was evacuated to Meldon Park near Morpeth and " The Sanderson " became an Emergency Medical Service hospital, both remaining under his charge. His relief was great when the children returned to Gosforth. Schemes for hospital extension then occupied his attention but were reluctantly set aside in 1948 on the " appointed day " when age compelled his retirement and the resumption of private practice.

Though Mackenzie was not given to writing he was a keen student of orthopaedics. In 1926 he combined with Rutherford Morison to publish an article on their treatment of dangle foot, and in 1947 his much quoted paper on sclerosis of the long bones or osteoid osteoma appeared in the *Journal of Bone and Joint Surgery*. For some years he made an extensive investigation into the nature of flat foot, and his material awaits an editor. Rare bone diseases attracted his interest, but such was his innate modesty that he gladly gave away to others whom he recognised as authorities his valuable observations on melorheostosis and on hyperplastic callus formation in fragilitas ossium for incorporation in their publications. Such integrity and disinterestedness were characteristic of himself and of his love for orthopaedics.

His later years were checkered by ill-health but he preserved a lively interest in the fortunes of his old hospital and in all the developments of medicine and of surgery. He died in October 1955 at the age of seventy-seven, leaving a widow and two daughters. J. G.

PROCEEDINGS AND REPORTS OF UNIVERSITIES COLLEGES, COUNCILS AND ASSOCIATIONS

GREAT BRITAIN AND IRELAND

UNIVERSITY OF LIVERPOOL

THE LADY JONES MEMORIAL LECTURE

The twelfth Lady Jones Memorial Lecture in the University of Liverpool was given at the Medical School on Wednesday, November 16, by Professor R. I. Harris of Toronto.

Having indicated the association of his own family with Liverpool, and consequently by hearsay his familiarity as a youth with the figures of Hugh Owen Thomas and Robert Jones, he turned to the subject of his lecture, " Hypermobile and Rigid Flat Foot." He described in detail the factors producing the hypermobile flat foot. He drew attention to the significance of inadequate support for the head of the talus and indicated the diagnostic features and the importance of shortening of the tendo calcaneus. Professor Harris stressed that the so-called " vertical talus " was an extreme example of the syndrome, indicating the possibility of a congenital basis for the acquired type. Lack of support of the arch could be alleviated by external support or by increasing the supporting action of the tibialis posterior, or in extreme cases by fusion of the tarsal joints. He also emphasised that many patients tended to improve with time and treatment, and that the condition did not necessarily cause trouble in adult life—except in the Services.

Professor Harris then described rigid flat foot with peroneal spasm, and stressed the importance of radiography, which usually showed lipping of the head of the talus, lack of clarity of the subtalar joint, and the presence of a bridge between the talus and the calcaneum. He described the special radiological technique that is needed to demonstrate such a bridge. There might be a complete or nearly complete bony bridge or only a fibrous band, or, if no actual bridge, there might be a mass of bone projecting from either the talus or the calcaneum. He described other abnormalities which could cause rigid flat foot, such as calcaneo-navicular synostosis, talus secundarius or, very occasionally, posterior talo-calcaneal fusion at the site of the os trigonum. Professor Harris said that incomplete bridges were more likely to cause symptoms. All his points were illustrated with extreme exactness by radiographs, photographs and sketches.

Professor Bryan McFarland presided and proposed the vote of thanks, which was passed with acclamation by a large and appreciative audience.

DEGREE OF M.Ch.(Orth) 1955

Eleven candidates were successful in the December 1955 examination for the degree of M.Ch.(Orth.). They were: M. Alms (Liverpool, England), Miss S. D. Bharucha (Bombay, India), P. G. Brady (Dublin, Ireland), H. Carrier (Quebec, Canada), H. S. Y. Fang (Hong Kong, China), P. Kilburn (Liverpool, England), H. Klein (Johannesburg, South Africa), I. Macfarlane (London, England), I. K. Sharp (Perth, Scotland), G. C. Slee (Liverpool, England) and H. Thompson (Liverpool, England).

The external examiners were Mr Norman Capener of Exeter and Mr Philip Wiles of London. The internal examiners were Professor Bryan McFarland, Mr Norman Roberts and Mr Eric Wardle.

OXFORD REGION

NUFFIELD ORTHOPAEDIC CENTRE

In November 1955 the Oxford Regional Hospital Board accepted the proposal made by the Management Committee of the Wingfield-Morris Orthopaedic Hospital to change its name to that of the Nuffield Orthopaedic Centre. This was done in accordance with the wish expressed by the late G. R. Girdlestone, who considered it an unavoidable act of public recognition to give to the hospital the name of the benefactor who, from its early times, had supported its development and had made possible its present set-up, which comprises 250 beds for " cold " orthopaedics, apart from the sixty to eighty for acute trauma kept elsewhere and the facilities for research.

In 1949 Lord Nuffield donated £50,000 to be added to the more than £600,000 he had previously given to the hospital and the University to further the development of orthopaedics. It was then that the name Nuffield Orthopaedic Centre was first used to cover a unified working body which would include the Wingfield-Morris Orthopaedic Hospital with its outside clinics, the accident service housed since 1940 at the Radcliffe Infirmary, the University Department, and the research laboratories which were then still to be built.

After six years of using the new name it has now been considered appropriate to substitute it for the old name of Wingfield-Morris Orthopaedic Hospital, as a token of recognition to the great benefactor to whom medicine in general owes so much.

The unfailing interest of Lord Nuffield in the development of orthopaedics has just been again manifested by a new donation of £200,000 to the orthopaedic hospital which now bears his name, to bring to final conclusion the plans for the advancement of this Centre in the three aspects of treatment, teaching and research. To fulfil Lord Nuffield's desires, planning has already started to bring the project into reality with the shortest possible delay.

Lord Nuffield should be congratulated for the altruistic way in which he helps the orthopaedic ideal of fighting the crippling conditions, not exclusively in the hospital wards but also in the laboratories where the fundamental work on which prevention of diseases is based may be successfully carried out.

During the past year the Nuffield Orthopaedic Centre has continued its several activities on the lines of the previous years. The study of the surgical treatment of congenital dislocation of the hip has continued, as also that of scoliosis. Analysis of results in the treatment of skeletal tuberculosis, tuberculous tenosynovitis, regeneration of muscle power after poliomyelitis, lumbo-sacral grafts, and other clinical investigations have been undertaken. In the pathological department and in the laboratories the pattern of blood flow in the growing upper femoral extremity has been investigated, together with the vascularisation of bone grafts, the effect of pressure on joints, and some other subjects. Several papers have been published based on these works.

The usual lecture series has been given during the university terms; the lecturers included Professor O. Scaglietti from Florence, Sir Reginald Watson-Jones, Professor Sir Walter Mercer, Mr W. Gissane, Dr E. G. L. Bywaters and Major L. C. Hollister. Apart from these, contributions were made by members of the Nuffield Orthopaedic Centre.

UNIVERSITY OF LONDON: INSTITUTE OF ORTHOPAEDICS

OPENING OF WELLCOME MUSEUM OF ORTHOPAEDICS

On Wednesday, April 4, Sir Henry Dale, Chairman of the Wellcome Trust, officially opened the Wellcome Museum at the Institute of Orthopaedics.

The Institute, which is part of the British Postgraduate Medical Federation of the University of London, is the teaching school at the Royal National Orthopaedic Hospital. It was established in 1946, and since then has undergone rapid expansion at both the London and the Stanmore sections of the Hospital. Postgraduate students from all parts of the world have come to the Institute to study orthopaedics and allied subjects. The development of a teaching museum has depended on the recent acquisition by the Institute of additional accommodation adjacent to the town hospital, and it has been greatly aided by financial support from the Wellcome Trust.

In introducing Sir Henry Dale, and in welcoming him and the other Wellcome Trustees, Sir Henry Floyd, Chairman of the Committee of Management of the Institute, and of the Board of Governors of the Royal National Orthopaedic Hospital, commented on the development of the Institute and on some of its teaching and research activities. He also paid tribute to the late Sir Henry Wellcome and to the present Wellcome Trustees for their outstanding aid to the development of research museums and libraries, and, in particular, he thanked them for their assistance in establishing the Museum—the " Wellcome Museum of Orthopaedics," as it would be called—at the Institute. This was one of the ways, he said, in which industry aided medicine.

Sir Henry Dale, in declaring the Museum open, congratulated the Institute on using a modest allowance of space and an equally modest allocation of money to set up what he believed to be a distinguished—in fact a unique—museum in the special field of medicine with which it was concerned. It could be seen, he said, that scientific thought—as well as admirable ingenuity of arrangement and display—had gone into the museum. He felt sure that, in the years to come, it would aid education and promote research in the various branches of medicine which had their application to orthopaedics.

The final speaker, Dr H. A. Sissons, Morbid Anatomist to the Institute and Curator of the Museum, briefly explained the aims of the Museum. He hoped that it would aid the teaching of orthopaedics—particularly by relating the clinical aspects of the subject to the underlying pathology

of disorders of the locomotor system—and that it would contribute to the research activities of the Institute.

The opening of the Wellcome Museum was marked by an exhibition " Pathology of Bones and Joints," in which a variety of pathological specimens and of other teaching and display material was shown. Some of this material was from the Wellcome Museum itself, while the remainder was loaned by other medical museums.

BRITISH ORTHOPAEDIC ASSOCIATION

VISIT TO THE UNITED STATES OF TRAVELLING FELLOWS IN ORTHOPAEDIC SURGERY

Five orthopaedic surgeons from the British Commonwealth have been elected to Travelling Fellowships under the scheme sponsored by the American Orthopaedic Association, the British Orthopaedic Association and the Canadian Orthopaedic Association, and will visit North America in May and June of this year. Those elected are : D. L. Evans (London), J. S. R. Golding (Jamaica), O. R. Nicholson (Auckland, New Zealand), A. G. Quinlan (Glasgow) and W. J. Sharrard (Sheffield). The provisional programme provides for an extensive tour of the middle and far West. The Fellows will also attend the combined meeting of the American and Canadian Orthopaedic Associations at Banff, Alberta.

NEW YEAR'S HONOURS LIST

We congratulate Mr L. W. Plewes on the honour of Commander of the Order of the British Empire, conferred upon him and announced in the New Year's Honours list for his important work in connection with the rehabilitation of the disabled in industry. Mr Plewes graduated in Toronto, Canada, in 1932, where he later held a Rockefeller Foundation Scholarship with Sir Frederick Banting. He came to England in 1934 to study orthopaedics first at the Royal Cripples' Hospital, Birmingham, and later at the Wingfield-Morris Orthopaedic Hospital, Oxford, where he was Nuffield Scholar under the late G. R. Girdlestone. In 1939 he organised an accident service at the Luton and Dunstable Hospital, and was largely responsible for the development of the well known unit for the rehabilitation of the injured at Vauxhall Motors. He is Chairman of the Board of Directors of Ludun Ltd., a voluntary organisation set up to employ severely disabled persons. As Treasurer of the British Orthopaedic Association he is, *ex officio*, a member of the Editorial Board of this Journal.

Mr L. W. PLEWES

SCIENTIFIC SOCIETIES AND REGIONAL ORTHOPAEDIC CLUBS

BONE AND TOOTH SOCIETY

The Bone and Tooth Society held a symposium on " Organic Components of Bone and Teeth " at the Institute of Orthopaedics, 234 Great Portland Street, London, on October 4, 1955. Dr H. J. Rogers was in the chair.

Some chemical aspects of the organic components of bone—*Dr J. E. Eastoe* reviewed work on the composition of the " ground substance " of bone tissue, as represented by the fraction soluble in dilute alkali and precipitated by acid. At least two components appeared to be present, one a polysaccharide of the chondroitin sulphate type, and the other a mucoprotein containing galactose and a protein moiety with an amino-acid composition altogether different from that of collagen. Mucoproteins of this type were becoming recognised as occurring widely in connective tissue in small amounts. Some recent data for the amino-acid composition of collagen from human and bovine compact bone were presented. These were obtained by the resin chromatographic method of Moore and Stein and enabled reasonably accurate comparison to be made with collagens from other tissues in various species. Among mammals, the composition of collagen was almost constant, whether derived from bone, skin or tendon. Among the lower vertebrates significant differences were, however, encountered.

The chemical nature of the organic matrix of dentine and enamel—*Dr M. V. Stack* said that during the later phases of enamel calcification an increase in the proportion of peptide material was

accompanied by a reduction in the amount of eukeratinous protein that could be isolated. The proportion of acid-soluble protein remained constant throughout. Carbohydrate and amino-sugar analyses matched the total organic content in fractions separated at different stages of calcification. Glycogen, histochemically demonstrable in developing dental tissues but not after maturation, was at present being determined in partly and fully formed enamel. Specific histochemical techniques had enabled several workers to demonstrate —SH groups in pre-dentine and pre-enamel, but the reaction disappeared as dentine calcified, being replaced by a weak —SS-bond reaction in enamel. Transfer of radioactive S in developing enamel had recently been interpreted as synthesis of an acid sulphomucopolysaccharide; this might prevent mineralisation of pre-enamel until matrix deposition had been completed. Hyaluronidase treatment during an examination for metachromasia distinguished this type of component from that associated with the mesodermally derived tissues.

Present knowledge of the metabolism of collagen, elastin and polysaccharides in connective tissues—*Dr H. G. B. Slack*, in a brief review, paid particular attention to the metabolic behaviour of the soluble collagen components and the polysaccharides. He outlined some of the immediate problems of connective tissue research, such as the mode of incorporation of ester-sulphate, and discussed the ways in which some progress in knowledge of the synthesis and breakdown of connective tissue components might reasonably be expected.

Fibrogenesis and the formation of matrix in embryonic bone—*Miss S. Fitton Jackson* described the investigation of the morphogenesis of long bone and membrane bone of the fowl embryo by means of thin sections and the electron microscope. It had been shown that as the extra-cellular areas were forming they became filled with firstly disorientated fine fibrils of less than 200 Å diameter, which might be a component of bone matrix, and secondly collagen fibrils with a periodicity of 670 Å. In regions where the organic material was just being deposited fibrogenesis was found to occur in intimate association with the surface of the fibrogenic cells. As the fibrous region widened, the collagen fibrils thickened and formed into bundles which became orientated into layers. Transverse sections showed that each individual fibril was invested by less dense interfibrillar substance; in order to account for the enlargement of the fibrils this substance was therefore presumed to contain collagen or the necessary precursors. Small crystals were then formed about 100 Å across and were localised almost exclusively in the interbands of the collagen fibrils. Gradually, and at a distance from the cells, an electron-opaque substance appeared and tended to mask the fibrous matrix. This stage in the morphogenesis of bone must have represented the beginning of calcification.

NORTH-EAST METROPOLITAN REGIONAL ORTHOPAEDIC CLUB

A meeting was held at St Bartholomew's Hospital, London, on November 26, 1955, under the chairmanship of Mr S. L. Higgs. A large and interesting series of cases was shown by the staff of the Orthopaedic Department. These included two medical students who had sustained severe injuries during the course of the Hospital's rugby cup ties; the first was a Brown-Sequard syndrome from a cervical disc lesion successfully treated by laminectomy; and the second with a total rupture of the medial capsule of the left knee, well stabilised at early open reduction by using the medial semilunar cartilage and the gracilis tendon.

Smith-Petersen nailing for slipped upper femoral epiphysis was reviewed, and a series of MacBride's operation for hallux valgus in young women.

A collection of cases of bone tumours with pathological specimens and sections was displayed.

During the discussion the members expressed their interest in two cases of resection of a whole digital ray in the foot, leaving function unimpaired, and thought it was an operation which might have a wider application.

SOUTH-EAST METROPOLITAN REGION ORTHOPAEDIC CLUB

A meeting was held at St Bartholomew's Hospital, Rochester, on October 22, 1955.

Mr P. G. Epps showed a series of cases of slipped upper femoral epiphysis with open reduction by subcapital osteotomy and nailing. In one late case it had been impossible to achieve complete reduction. Union was doubtful six months after operation, and a debate took place on the need for further treatment. Mr Epps maintained that it is always wise to remove stainless steel nails in young patients because of their proximity to the joint. The consensus of opinion favoured removal of the nail and subtrochanteric osteotomy in this case, in view of the persistent deformity and doubt about bony union in the femoral neck.

Among his other cases Mr Epps showed a young married woman with multiple destructive lesions affecting the lumbar and cervical spine. These lesions were diagnosed radiologically after periodic attacks of discomfort with malaise and pyrexia, but on each occasion the symptoms had

improved by the time the lesions became manifest on radiography. Four separate lesions had developed in this way and all appeared to have healed spontaneously. Penicillin seemed to have helped towards recovery and the patient appeared very fit when seen at the meeting. The nature of these lesions was discussed, and though most members seemed willing to accept Mr Lloyd Williamson's diagnosis of staphylococcal osteitis Mr C. G. Attenborough suggested that eosinophil granuloma should be excluded by biopsy of any future lesion that might occur.

Mr A. C. Hume showed three cases of anterior dislocation of the head of the radius with undisplaced fractures of the olecranon in children. He pointed out that these cases were not of the Monteggia type and that the head of the radius was dislocated forwards in each case. This appeared to be due to a pronation and extension injury. Reduction had been simple in a position of flexion and supination. One patient had developed fairly extensive myositis ossificans. Sir Reginald Watson-Jones could claim no experience of this type of injury but he agreed that this was a primary forward dislocation of the head of the radius. He thought that there was some forward displacement of the lower epiphysis of the humerus in one of Mr Hume's cases. He congratulated Mr Hume on bringing forward this series and expressed the hope that we should hear more of this condition.

Mr O. J. Vaughan-Jackson showed a series of difficult congenital dislocations of the hip. These included one child who had come under treatment at the age of seven, upon whom a Colonna operation with adductor tenotomy had been successful after the application of skeletal traction. Another of these cases with recurrent subluxation and osteochondritis of the femoral head was presented for suggestions as to further treatment. It was agreed that the degree of anteversion of the femoral neck must be estimated before a decision could be reached on the advisability of a shelf operation, rotation osteotomy, or exploration of the joint with a view to removal of a displaced limbus.

Mr Vaughan-Jackson also showed a young woman with incomplete paraplegia after coal-gas poisoning, in whom large deposits of new bone had been laid down in front of both hip joints. These deposits formed on each side a complete bony bridge from the acetabular margin to the upper femoral shaft. At operation they lay in front of the joint capsule and were separated without undue difficulty from the surrounding structures, including the rectus femoris tendons, which lay in grooves in the bony deposits. Mr Vaughan-Jackson had made a complete removal of the bony bridge on each side in a single piece and showed the specimens. A satisfactory range of hip movements had been regained. Sir Reginald Watson-Jones pointed out that abnormal bony deposits were usually subperiosteal and no one present could offer a satisfactory explanation of why such deposits occurred in paraplegia, or of the unusual situation of the deposits in the case demonstrated. Mr Vaughan-Jackson was congratulated on the excellent result.

Mr J. R. Briggs showed three cases of nerve compression at the wrist. In two of these the compressing agent had been a ganglion. In the third, three large protrusions of synovial membrane projecting on the ulnar and radial borders of the wrist and into the carpal tunnel had compressed the ulnar, superficial radial and median nerves. The wrist was osteoarthritic after an old fracture of the scaphoid with excision of the proximal half of this bone. Removal of the synovial protrusions had relieved this patient's symptoms but he later developed a recurrent similar synovial protrusion in the path of the superficial radial nerve. Subsequent removal of this again relieved the symptoms. Sections of the " tumour " showed the changes of pigmented villo-nodular synovitis.

Mr W. de M. Kellock showed a mother and son with identical congenital dysplasia of the hips and a mother and daughter with marked pes cavus.

Mr R. H. V. Hafner showed a child with an osteoid osteoma of one tibia. He pointed out that this condition was commonest in adults, but that it had been described at all ages in childhood, even in infancy.

Among his other cases Mr Hafner showed a patient who had developed extensive paralysis in both upper limbs which had been attributed to serum sickness neuritis after an injection of anti-tetanic serum. Several such cases had been described in the literature, always following anti-tetanic serum, never toxoid. Prognosis was usually good, but though there had been a considerable early recovery in the case demonstrated, a great deal of wasting of the shoulder girdle and forearm muscles remained on one side. Mr Hafner thought this condition was similar to a form of paralytic brachial neuritis seen during the last war in the Middle East. Mr B. Lawson recalled two similar cases. Mr L. Linder maintained that anti-tetanic serum was not the only possible cause of such a condition. He himself had suffered such a parlaysis associated with severe pain, after an immunising inoculation against yellow fever consisting of a simple saline suspension of virus containing no serum whatever. He was inclined to attribute the paralysis to poliomyelitis, but Mr Hafner insisted that poliomyelitis of such severity must also have involved the legs at some stage.

EAST ANGLIAN ORTHOPAEDIC CLUB

A meeting of the East Anglian Orthopaedic Club was held on November 26, 1955, at the Newmarket General Hospital, with Mr G. K. McKee in the chair. Clinical demonstration was led by Mr E. C. Jamieson.

Tuberculous hip disease—*Mr E. C. Jamieson* began by discussing the manifestations of tuberculous hip disease, showing how these varied. Often it was difficult in the early stages to be more precise than to recognise a hip in trouble. This could be as little as a transient synovitis in patients with known tuberculosis of the lungs which settled down completely with streptomycin and rest. Sometimes in children this could occur without a known lesion elsewhere, and in these biopsy was seldom helpful. He went on to show a patient with extensive destruction which apparently healed, but Pott's disease developed later. Tomography showed a residual cavity. He quoted a similar case in which tuberculous arthritis developed in the knee.

Mr Jamieson then demonstrated cases in which there was extensive destruction of joint cartilage and abscess and sinus formation, cases in which the lesion was para-articular with extensive destruction, and a case of a hip in painful spasm in which the epiphysis of the femoral head became dense and eventually formed a sequestrum. In these he advocated the removal of the head if possible.

A discussion followed on the relative value of arthrodesis and osteotomy and by what mechanism the latter did good.

Extensive wounds of the thigh—*Miss M. Welply* showed three cases of extensive wounds of the thigh, in which severe muscle damage left much less weakness than might have been expected. Mr Bell Jones said that function would be good unless there was also damage to intermuscular septa.

Bilateral congenital dislocation of hip—*Mr R. C. Howard* showed the films of a girl with congenital dislocation of both hips reduced successfully by manipulation and held in plaster at two years of age. Two years later the hips redislocated and the femoral heads were seen to be riding up. There was persistent pain, now associated with a subacute arthritis of both hips. Various means of treatment were discussed—arthrodesis, arthroplasty or bed rest on a Thomas's frame.

Congenital absence of femur—*Mr Jamieson* demonstrated a small boy with a congenital absence of femur treated by a pylon in which he was able to climb, walk and kick a ball.

Osteomyelitis—*Miss Welply* showed a case of osteomyelitis in a boy of fifteen in which lesions were seen in both ends of the femur. The whole shaft formed a sequestrum which was gradually absorbed and replaced by a full-length involucrum which had gradually modelled into a fresh shaft very similar to a normal one.

Gross dilation of left jugular vein—*Mr Jamieson* reported the case of a young woman who was thrown from a horse and had a flexion injury of her neck. Radiographs showed no bony abnormality, but a month later she developed gross dilation of the left external jugular vein on laughing or coughing. There was no sign beyond a little tenderness behind the middle of the clavicle. A venogram showed no obstruction. Exploration was carried out but no explanation was found; nevertheless the operation was followed by a good cosmetic result.

Lymphatic leukaemia—*Mr R. Fleming* reported the case of a woman who in 1950 fell from her bicycle and hurt her leg. Radiographs showed a fractured femur and she was treated by pin traction. Six weeks later the radiographs showed changes in the bone at the site of fracture, which failed to unite. The patient began to deteriorate and died. The lesion was found to be a deposit of lymphatic leukaemia, but no other bony deposits were known.

A further meeting of the club was held on Saturday, January 28, at the Thorpe Hall Rehabilitation Centre, Peterborough, with Mr T. J. Fairbank in the chair.

Surgery of the hand—*Mr R. G. Pulvertaft*, of Derby, was introduced by Mr Noel Smith and gave a most illuminating lecture on the subject of hand surgery, illustrated by a collection of his own slides which showed his technique very clearly and demonstrated the excellent results possible. This was followed by a film illustrating some special examples of problems in the hand. The clarity of his descriptions and the beauty of the photography together made a memorable lecture.

SOUTH-WEST ORTHOPAEDIC CLUB

On November 26, 1955, the South-West Orthopaedic Club met for the first time at the new Prince of Wales Orthopaedic Hospital, Rhydlafar, Cardiff, under the chairmanship of Mr A. O. Parker. Forty members were present.

A method of mounting specimens—*Professor Jethro Gough* gave a short talk on the method devised by him ten years ago for mounting pathology specimens. He had used the method at first in connection with research on pneumoconiosis, but later had extended it to all tissues. Sections of the tissue were cut in frozen gelatine and mounted on filter paper. The tissues had been previously suitably stained

to maintain their colour so that they resembled a very beautiful transfer. The method was partly used for research, for records and for teaching purposes. Professor Gough had sent many specimens abroad, especially to India where they were used for teaching purposes, it being impossible for necropsies to be performed there for religious reasons. The actual technique was not expensive.

Several interesting sections were shown including those of Albers Schönberg disease of the femur, which stained deeply with haemalum while normal bone did not. This, Professor Gough considered, might open up an interesting line of research. A Ewing's tumour of femur and of rib and a chondroma of finger were also demonstrated.

Fractures of the sternum—*Mr A. W. Fowler* said that fractures of the sternum occurred in road accidents and resulted from two mechanisms, a direct blow or crush and hyperflexion of the trunk. Two distinct syndromes existed which could be distinguished clinically and radiologically.

Mr Fowler reported four cases. In two the sternal injury was unstable after reduction and Kirschner wire fixation was used.

The late results of Smith-Petersen nailing for fracture of neck of femur—*Mr R. A. J. Baily* reported a follow-up of 139 consecutive transcervical fractures of the neck of the femur operated on at the Bristol Royal Infirmary and at Winford between Janauay 1951 and June 1953. He found that the result was good or excellent in 42 per cent. The bad results were ascribed to avascular necrosis and not to non-union. There were nine deaths in the first three months after operation (6·5 per cent).

An interesting feature was that the six patients in the series under the age of forty-five years all achieved union without avascular necrosis, with good functional results.

Nerve lesions about the elbow—*Mr G. G. H. James* reported four unusual cases of nerve lesions about the elbow.

1) Ulnar neuritis in a woman of forty-two who used her right hand to stamp 5,000 cartons a day with a machine. She had been so employed for eight weeks when she felt something " give " in her palm and she developed numbness on the ulnar side of the hand. There were pain and sensory loss in the distribution of the ulnar nerve. She was kept under observation and six months later was found to have a complete ulnar palsy. There were no other objective signs in the hand or wrist, but there was pain and limitation of movement at the elbow. The ulnar nerve was explored at the elbow and was found compressed by an anatomical rarity—the epitrochleal anconaeus muscle. The nerve was released and transposed, with complete recovery.

2) A laboratory assistant of eighteen had a complete ulnar palsy complicating a fracture of the medial epicondyle of the humerus with dislocation of the elbow. At operation the epicondyle was found pulled downwards and was causing pressure on the nerve, which was in continuity. The nerve was transposed and the epicondyle was excised, with complete recovery. Mr James felt that there was a place for suturing back the epicondyle because lateral instability of the elbow sometimes followed excision of the medial epicondyle for this injury.

3) A civil servant of forty-six fractured the head of the radius and, contrary to medical advice, tried to encourage extension of the elbow by carrying heavy buckets of water. Later he developed pain in the thumb and index finger with weakness of the hand, and was unable to write. On examination he was found to have a median and an ulnar nerve palsy, and radiographs showed myositis ossificans. The mass of bone was causing pressure on the median and ulnar nerves. After excision of the mass he made a satisfactory recovery.

4) A girl of eighteen with Volkmann's ischaemia and complete median and ulnar nerve palsy complicating a rotation osteotomy for congenital radio-ulnar synostosis. The rotation osteotomy was performed to give more supination in order that she might assist in a greengrocer's business. The bones were fixed with plates after the rotation osteotomy and a padded plaster was applied. A considerable amount of recovery of sensation occurred without any operative intervention.

Bankart's operation for recurrent dislocation of shoulder—*Mr K. H. Pridie* briefly recounted the early history of recurrent anterior dislocation of the shoulder. He said that " if a horse escapes from the stable with a broken door the proper treatment is to repair the door and not hobble the horse." For this reason he felt that Bankart's operation was more logical than the Putti-Platt procedure. The original Bankart operation was very difficult to perform and on this account was viewed with disfavour. He had devised an operation to staple back the capsule and had performed this nine times. He used an anterior approach and did not divide any muscle. The coracoid process was not disturbed, but the subscapularis was exposed by retraction of the coraco-brachialis to the outer side. A large stainless steel staple was then inserted through the subscapularis into the neck of the scapula. After three weeks movements were allowed and the patient was permitted to return to work. Usually full movement was regained. There had been no recurrence of dislocation. Four patients had been followed for two years, three for one year and two for six months. He assumed that the trauma caused by the insertion of the staple possibly " stuck down " the capsule. *Mr E. Mervyn Evans* said

that the original Bankart operation was quite easy provided that a right-angled drill was used and the Bankart skid was employed to secure adequate vision. *Mr A. O. Parker* said that fibrosis of the subscapularis muscle appeared to be important. Naughton Dunn had reported many years ago that he obtained satisfactory results merely by dividing the subscapularis muscle and not sewing it back into position.

Tuberculous tenosynovitis—*Mr H. J. Richards* reported seventy collected cases of tuberculous tenosynovitis. Of these thirty-nine were compound palmar ganglia and nineteen involved the flexor tendon sheath of the fingers. There was joint involvement in eleven cases.

The reaction produced by the infection was of three types: 1) exudative, with production of fluid and melon-seed bodies, and with slight proliferation of the sheath; 2) proliferative, with marked synovial proliferation and little fluid; 3) caseous, with marked proliferation and caseation. This type was most likely to destroy the tendon.

As regards treatment, it was clear that complete excision and chemotherapy gave the best results. In seven cases treated in this way there was no recurrence. Complete excision alone was also successful, as in seventeen cases there had been only three recurrences.

Conservative treatment consisting of splintage only had failed in all of twelve cases, and partial excision was also unsuccessful. Mr Richards showed a film of the operation of excising the thickened flexor retinaculum in a case of compound palmar ganglion involving also the flexor sheath of the finger.

The afternoon was devoted to clinical demonstrations.

Club foot—*Mr Dillwyn Evans* showed cases of cavo-varus deformity of the feet treated by excision of a crescentic wedge from the lateral aspect of the calcaneum, as suggested by Dwyer. The deformity appeared to result from relative weakness of the evertor muscles; once the heel started to invert, the tendo calcaneus tended to accentuate the deformity. Correction of the varus deformity of the calcaneum combined with division of the tight plantar structures gave a much improved foot.

Mr Evans also showed cases of relapsing club feet in children of six to eight years treated by division of all the contracted soft tissues, by wedge excision of the calcaneo-cuboid joint, and by transplantation of the tibialis anterior to the middle or outer side of the foot, all carried out at one operation. The results were better when good correction was first obtained by wedged plasters.

Traumatic paraplegia—*Mr E. Meurig Williams* gave a brief talk on the management of traumatic paraplegia at the Cardiff Centre, using the plate invented by him which facilitated fixation of the vertebral spinous processes. He also demonstrated a method of turning the patient with the knees flexed and using a draw sheet. The bladder was catheterised twice daily.

Surgery in rheumatoid arthritis—*Mr D. M. Rocyn-Jones* showed a woman with rheumatoid arthritis who had been unable to sit up for ten years and who had stiff knees, hips and elbows. Excision of the head and neck of the femur, on both sides, and arthroplasty of both elbows had been performed. After the operations she was able to walk unaided with crutches, and to feed herself.

Arthrogryposis—*Mr Rocyn-Jones* showed the results of muscle transplants in a boy of eight with arthrogryposis and with no power of flexion in the elbows. Clark's pectoralis muscle transplant had been performed on both sides. On the right, as no biceps tendon was present, the pectoralis muscle was prolonged into the radius by means of a graft of fascia lata. After the operation it was possible for him to flex the elbow to 90 degrees. On the left side the pectoralis major was put into the remnants of the biceps tendon. The latter operation had been performed only one month ago and so far showed promise.

Eosinophilic granuloma—*Mr E. Mervyn Evans* showed a patient with a painful shoulder due to an eosinophilic granuloma of the under surface of the glenoid. The diagnosis was established by biopsy. The patient always experienced pain after drinking beer, in this respect resembling some patients with Hodgkin's disease with deposits in the spine, who had increased pain after drinking alcohol. The condition cleared after deep x-ray therapy.

Actinomycosis—*Mr Mervyn Evans* showed a patient of forty-three who fourteen months ago had pneumonia and meningism which settled after the administration of aureomycin. One year ago she had a similar illness which settled after another course of aureomycin. Examination of the cerebro-spinal fluid revealed a slight increase in cells, but no other abnormality. A few months later the patient was readmitted with backache, a high temperature and neck rigidity. Lumbar puncture produced actinomycotic pus. Radiographs revealed some fluffiness at the lumbo-sacral angle. Intrathecal injections of penicillin and streptomycin were given for four weeks. At the end of this time the cerebro-spinal fluid was normal and the patient made a complete recovery. Radiographs later revealed a definite bone focus in the lumbo-sacral joint.

Staphylococcal spondylitis—*Mr E. Mervyn Evans* showed a boy of fifteen with an abscess in the fourth lumbar vertebra due to staphylococcus pyogenes. Although treated with chemotherapy many times, a cure had not been effected and " flares " continued. He had developed a metastatic abscess in the

tibia which required drainage. More recently a perinephric abscess had formed and radiographs revealed a chronic bone cavity in the fourth lumbar vertebra.

It was considered that only radical drainage might minimise the tendency to recurrent abscess formation and that the cavity within the vertebra could be approached through a lateral incision as for sympathectomy. Slough, sequestra and perhaps necrotic disc substance, which were perpetuating the discharge, might then be removed by curettage.

IRISH ORTHOPAEDIC CLUB

The autumn meeting was held on Saturday, November 19, 1955, in Cork.

In the morning *Mr St John O'Connell* reviewed his series of Smith-Petersen nailings for fractured femoral necks. He also described some of the problems and difficulties of the orthopaedic service as it was constituted in his area.

Mr N. S. Martin showed some films which he had made himself. These were of various orthopaedic procedures and were excellent.

Mr R. F. O'Driscoll discussed arthroplasty of the tempero-mandibular joint and showed one illustrative case.

There followed a symposium of osteoarthritis of the hips at which a film of the Fitzgerald arthroplasty was shown. The guest speaker at the discussion was Mr J. Crawford Adams of London.

The president of the University College entertained the Club members to lunch.

In the afternoon the Club visited the newly opened St Mary's Orthopaedic Hospital in Cork. This hospital was greatly admired by all members. It is beautifully situated and is obviously destined to become an important centre.

A clinical demonstration in which interesting cases were shown by Mr O'Connell followed. These cases were widely discussed by the members.

This first meeting in Cork was thoroughly enjoyable, and the Club is looking forward to a return visit.

SOUTH AFRICA

SOUTH AFRICAN ORTHOPAEDIC ASSOCIATION

FOURTH CONGRESS

The Fourth Congress of the South African Orthopaedic Association was held in Pretoria in conjunction with the Annual Scientific Meeting of the Medical Association of South Africa from October 17–21, 1955. The meetings were presided over by Mr J. M. Edelstein. Distinguished guests from outside South Africa included Professor Bryan McFarland of Liverpool, Mr John Charnley of Manchester, Dr H. Kessler of Newark, New Jersey, and Mr G. Pollock of Edinburgh.

Social engagements of note during the Congress were participation in the Pretoria Centenary Celebrations, a visit to the Kruger Game Reserve, and the annual orthopaedic dinner.

Sir Reginald Watson-Jones and Professor Bryan McFarland were elected honorary members of the South African Orthopaedic Association.

The following officers were elected for the ensuing two years: *President*, Mr C. T. Moller; *secretary*, Mr S. Sacks; *treasurer*, Mr W. T. Ross.

Congenital dislocation of the hip—*Professor Bryan McFarland* (Liverpool) discussed the subject from the broad point of view, and stressed the diagnostic importance of the summation of physical and radiological signs. Telescoping, and the sloping acetabular roof, were most significant. Where doubt existed in the infant, he advised treatment by means of simple abduction until the diagnosis could be found. Early diagnosis, and the type of dislocation, were the two most important prognostic points, and three types were recognised: 1) the good hip with mild displacement; 2) the good hip with severe displacement; and 3) the bad hip with severe displacement. Treatment in the first type was easy if commenced early. Abduction of the hips sufficed. The second type was treated by manipulation up to the age of eighteen months and was still easy: traction was exerted in the line of the thigh with hip flexed to 90 degrees. A thumb was then placed on the greater trochanter which was pushed medially, and the final movement home of the hip was accomplished by slight medial rotation. Immobilisation was by plaster, with hips abducted a little above a right angle and slightly medially rotated. The thighs were placed a little in front of the coronal plane. Full abduction with medial rotation while the thighs were maintained in the coronal plane caused maximum pressure on the femoral head and favoured osteochondritis. Sudden changes in the position of the hips were similarly productive of necrotic changes.

Late cases of the second type were difficult. Manipulation with or without a preliminary period of fourteen days' traction might succeed. If not, he favoured open reduction for the clearance of soft tissues from the acetabular cavity. He regarded excision of the limbus as harmful, as the limbus was in his opinion more than ever necessary in order to lend support to the sloping acetabulum. Derotation operations were redundant, as anteversion never exceeded 5 degrees in early cases, and developed only as a result of prolonged chronic dislocation. Open reduction should never be followed by prolonged immobilisation in an unnatural position, as an abduction deformity could result and might prove difficult to correct. Should the hip be stiff after operation, *do nothing;* it will loosen up within two years.

The third type, when seen early, could be treated relatively easily, and with good effect. If seen late, treatment was very difficult. Unilateral cases were justifiably attempted in the full knowledge that the resulting stiff hip would nevertheless be acceptable. When bilateral, it was probably best to do nothing, and deal with later problems as and when they arose.

Colonna acetabuloplasty was of value up to the age of five years, and the shelf operation after five years. Late cases in which osteoarthritic changes were present were probably best treated by the Lorenz osteotomy.

Mr A. Lewer Allen (Durban) was convinced that congenital dislocation of the hip in Bantu babies was usually reduced by the mothers who carried them on their backs, tightly wrapped in a shawl and with hips abducted. *Mr R. Hamilton Bell* (Capetown) felt that in cases of arthrogryposis multiplex congenita dislocation of the hips was best not treated, as any form of treatment resulted in stiff hips. *Mr R. C. Craig* (Johannesburg) thought that in a small percentage of unstable reductions redislocation occurred after prolonged immobilisation, and required open operation. *Professor McFarland* advised that in these cases the children be allowed to kick about for two or three months, then subjected to open operation at which the acetabulum was cleared out and a valgus osteotomy performed.

Fractures of the calcaneum—*Mr M. Lunz* (Johannesburg) reviewed the literature, and traced the first constructive contribution to Böhler in the early 1930's. The next great advance was made by Ivor Palmer of Sweden some ten years later, to whom he gave credit for the excellent modern approach to the subject. Only those fractures that involved the subtalar joint were considered. A small percentage were not displaced and presented no problem. Yet another group were so severely comminuted that only arthrodesis could be considered. About 70 per cent were of the " joint depression " type and the " tongue " type, these being the cases with which his paper was concerned. Those of the " tongue " type could be reduced with the aid of the Gissane calcaneal spike; whereas those of the joint depression type required the addition of an open reduction.

The Gissane spike and introducer were used in both types and the spike was incorporated in a short plaster boot for six weeks. This spike eliminated the need for a bone graft to fill the hollow created by the elevation of the depressed lateral fragments. The gap which was so created soon filled with blood clot, which became organised and later ossified. Weight bearing was allowed ten weeks after reduction, and the patient returned to full duties with a well shaped foot within six months of injury.

Treatment of mono-articular arthritis of the hip by the central dislocation operation—*Mr John Charnley* (Manchester) described the operation, and elaborated upon recent developments, which aimed at producing bony fusion in six or eight weeks, or fibrous ankylosis if desired. The strength of fibrous ankylosis lay in the bone block produced by the base of the femoral neck against the lips of the acetabulum, thereby protecting the fibrous tissue of the ankylosis from tension. An analysis of 105 cases revealed excellent or good results in 88 per cent of cases, and " no better " or " worse " in only 3 per cent.

Technical improvements in the form of a fixation screw with spring compressor, as well as an anti-flexion device, assured absolute immobilisation, and in his opinion guaranteed bony union within two months. On the other hand, the retention of some movements could be guaranteed by proper selection of the case. When the femoral head was not too large it could be dislocated intact into the reamed-out acetabulum; the presence of its eburnated cartilage would prevent bony ankylosis. Further improvement in hip surgery could be expected from the development along these two divergent lines. He considered arthroplasty a poor operation, in view of the pre-operative weakness of the hip muscles in the presence of hip pathology. Mobility was therefore an unattainable ideal, whereas stability and painlessness were a practicable proposition. He regarded a fully mobile knee as essential if hip arthrodesis were to succeed. When fibrous ankylosis was the end-result, movement in excess of 40 degrees would indicate failure. Painlessness was however still possible in such a case and constituted the principal criterion. *Mr R. Hamilton Bell* (Cape Town) had found that when the head was made to fit accurately and closely into the reamed-out socket, bony fusion was assured and a plaster was unnecessary. *Mr Charnley* did not consider absolute accuracy of fit of head into

socket to be important. The absence of air space between trochanter and pelvis was much more desirable. *Professor Bryan McFarland* (Liverpool) considered that the results of the central dislocation operation were every bit as good as those of displacement osteotomy, and that the operation constituted one more useful procedure in the treatment of hip joint disease. *Mr Charnley* believed, however, that osteotomy never gave rise to arthrodesis, which in some cases was very desirable. *Mr J. G. du Toit* (Pretoria) expressed concern at the number of potential backaches following hip arthrodesis in the presence of lumbar spondylosis. *Mr Charnley* was not worried about this problem which had not proved real. *Mr A. C. Boonzaier* (Johannesburg) had performed this operation in thirty-six patients with hip joint tuberculosis, both in children and in adults, and was very satisfied with his results.

Monteggia fracture—*Mr A. D. Polonsky* (Johannesburg) defined this relatively rare injury, and emphasised the difficulties of treatment in late, neglected cases. He preferred open reduction of the ulnar fracture with massive onlay grafting, and subsequent excision of the radial head. Premature excision of the radial head prejudiced the stability of the ulnar fixation, and excision of the radial head in children at any stage was a procedure of very doubtful value.

There appeared to be no answer to the problem of the fractured radial head in children; excision did not materially improve function, and the danger of cubitus valgus was a very real one. Excision was never necessary in the case of extension injuries, where the head was dislocated forwards. *Mr Leo Mirkin* (Port Elizabeth) considered bone grafting unnecessary, as plating of the ulnar fracture was adequate, and he combined this with reduction or excision of the radial head. He disagreed with Mr Polonsky's statement that Monteggia fractures occurred in natives as a result of fighting with heavy sticks. They sustained fracture of the ulna at the junction of the middle and distal thirds.

Anterior inter-corporal spinal fusion—*Mr J. G. du Toit*, *Mr G. F. Dommisse* and *Mr L. H. Muller* (Pretoria) presented their results in a series of 100 cases of intervertebral body bone graft for spondylolisthesis and for disc degeneration with local instability. The operation was performed after the technique of Cloward of Honolulu, but with three modifications—namely, the use of stored bone from the iliac crest; the total removal of the pseudarthrosis in cases of spondylolisthesis, and the use of a box-shaped osteotome. The latter was of great value in removing the disc and creating a bed for the pre-shaped bone grafts. Assessment of end-results was incomplete, but there was little doubt that in only a small percentage of cases could bony ankylosis be demonstrated. Nevertheless the clinical results justified the method. A film illustrating the operation was shown. *Mr John Charnley* (Manchester) wished to differentiate clearly between backache on the one hand, and sciatic pain on the other. He felt that treatment could be successfully directed against sciatic pain only, whatever the method employed. He advised that the film he had just seen be displayed in the waiting room of orthopaedic clinics for the benefit of the numerous backache sufferers who filled the pews. *Professor Bryan McFarland* (Liverpool) also believed that radiographic evidence of fusion did not constitute an important criterion in assessing the results. He was of the opinion that the cause of spondylolisthesis was essentially an inherent bony defect in the pars interarticularis which became manifest at a later stage only when a form of stress fracture probably came into being. *Mr G. T. du Toit* (Johannesburg) favoured the simple interlaminar approach for removal of a disc. This cured 70 per cent of the patients, while 20 per cent retained a certain amount of backache. Only in the remaining 10 per cent was some form of spinal fusion warranted.

Slipped upper femoral epiphysis: its early diagnosis and treatment—*Mr J. M. Edelstein* (Johannesburg) considered that the prevention of osteoarthritis of the hip had become overshadowed by the current preoccupation with the treatment of the already developed condition. Early recognition required the full cooperation of the general practitioner, and it was a sad reflection that in a personal series of twenty-seven cases, only four had been diagnosed early. Treatment of the early case was easy, and consisted of internal fixation before severe displacement had taken place. He considered as fit for nailing " in situ " the head epiphysis which had not slipped more than one centimetre, and it was therefore essential that the nailing should be performed immediately the diagnosis was established.

From an analysis of the twenty-seven cases he concluded that the result of treatment of the late case was problematical, and though open reduction plus internal fixation of the displaced head was a reasonable approach, it was complicated, in a number of cases, by ischaemic necrosis of the femoral head. It was significant that in no single old case in his series where no treatment at all had been given, did this complication occur. Though several of his patients operated upon by transcervical osteotomy and nailing escaped necrosis, those that did develop this complication served to emphasise the need for early diagnosis and nailing in the early phase of slipping. All the cases diagnosed at a stage of minimal slipping achieved a perfect result.

Early recognition was not difficult provided the condition was borne in mind and a limp in adolescence was not ignored. *Professor Bryan McFarland* felt that the problem was straightforward—

the early case was readily amenable to treatment and a good result could be expected with internal fixation " in situ," whereas in the late and neglected case the hip could never be normal again. *Mr F. P. Fouché* (Johannesburg) stressed the frequency of bilateral incidence, and had often been led to suspect the diagnosis when the patient complained of pain in the opposite knee.

Arthroplasty of the hip: an analysis of thirty-two operations—*Mr W. T. Ross* (Johannesburg) traced the history of the subject from the first attempts at hip arthroplasty by means of excision, as described by John Barton of Philadelphia in 1827, and James Syme of Edinburgh in 1831. These operations formed the basis of the more modern procedures, such as those of Robert Jones, Whitman, Colonna, Girdlestone, Bankart and Batchelor. Next followed the " interposition arthroplasty " by Helferich (1894) who interposed muscle between the resected surfaces of the tempero-mandibular joint. Numerous types of interposition material were then described, all of them useless and some of them dangerous. Sir Robert Jones used malleable gold foil in 1902, and an arthroplasty for an ankylosed hip was still successful after twenty-one years. Smith-Petersen mould arthroplasty attained its greatest success with the advent of Vitallium, and this work was followed by the " replacement arthroplasty " of the Judet brothers in Paris (1946). Failure of the replacement arthroplasty was, however, to be expected in view of the loosening of the stem of the prosthesis, brought about by pressure necrosis from weight bearing. For this reason, Mr Ross preferred the mould arthroplasty to the replacement technique, and a follow-up of his series left no doubt in his own mind. *Mr John Charnley* was strongly opposed to any form of replacement arthroplasty, which, in his opinion, was doomed to failure if only because of the coefficients of friction involved between metal or arcylic material on the one hand, and bone or cartilage on the other.

Supracondylar fracture of the humerus—*Mr B. Polonsky* (Johannesburg) outlined the mode of production, diagnostic features and dangers inherent in this common fracture, and emphasised the heavy responsibility which rested on the general practitioner in its management. Closed methods of reduction were to be preferred to open, and a plaster slab with the elbow almost fully flexed was advocated for a period of six weeks. Complications included Volkmann's ischaemic contracture, and permanent paralysis of the flexor profundus to the index finger. The presence or absence of the radial pulse at the wrist was not always a reliable guide to the state of the peripheral circulation. *Mr Carl Moller* (Johannesburg) stressed the value of open operation in cases of arterial or nerve lesion, and described cases in which these structures could be freed from the fractured fragments by no other method. Unfortunately, arterial damage was in some of these cases found to be irreversible.

The role of supracondylar osteotomy in conjunction with subtrochanteric medial displacement osteotomy of femur—*Mr A. Lewer Allen* (Durban) presented a case of an unstable painful hip with degenerated femoral head after Smith-Petersen nailing ten years previously. A Lorenz bifurcation was done with purposely an excessive abduction, to be later corrected by supracondylar adduction. The thesis underlying this procedure was that stability of the hip was dependent upon prominence of the trochanter as well as the shift medially of the weight-bearing thrust. The increase of trochanter protrusion was based on the following argument: hip stability depends, *inter alia*, on the tensile strains set up in non-stretchable material like fascia and tendons more than on maintained muscle action. The analogy of a sailing-ship's mast and its stays was used. The femur was the mast, and the deck was the innominate bone. This inverted mast was stepped on, *not in*, the deck. The main lateral stay or "shroud" was the fascia attached to the iliac crest down to its condensation into the ilio-tibial band. This " shroud " was unstretchable but was adjustable by the combined or reciprocating actions of both the tensor fasciae latae and the gluteus maximus. The " cross tree or outrigger " of the mast was the trochanter, which became more effective with increased prominence. It was important that this stay mechanism should be able to move over its "cross-tree end" and at the same time take pressure. Hence the significance of the trochanteric bursa and also of the fact that the gluteus maximus was developed only in the anthropoids, and was proportionately greatest in man. There was also the combined insertion of the gluteus maximus into bone and the fascia, and, for what it was worth, the same nerve supply to the tensor fasciae latae and gluteus maximus. The need for a conception of angles of apparent, versus actual, abduction was atressed. Other points included the site of antero-posterior counterpoise, which with the outlines were presented as superimposed over the outlines of Leonardo da Vinci's proportions of the human figure, after Vitruvius.

Recurrent dislocation of the shoulder—*Mr G. T. du Toit* (Johannesburg) presented a paper based on work done by Mr David Roux and himself. Two hundred and ten cases treated by many Johannesburg surgeons over a period of twenty-four years were analysed to determine the efficiency of the stapling operation. The historical development of the Johannesburg operation was traced from the pioneer work by F. P. Fouché and A. Lewer Allen to the technique now used by the authors. The modern operation consisted of a delto-pectoral approach, splitting the subscapularis along its fibres, division

of capsule in the same plane, recognition of the Bankart lesion of labral detachment, and fixation of the labrum and capsule by marginal stapling.

A special staple introducer was used to insert 1½-inch staples with ⅜-inch gap. Colour slides demonstrated details of the technique. The modified technique had reduced the disability period from six weeks to two weeks because no muscles were divided in the muscle-splitting exposure of the lesion. Results demonstrated full range of movement in six days and an absence of complications in long follow-up cases.

Recurrences were few. Some were due to technical errors and were cured by further operation. Cases with congenitally lax capsules, and cases associated with paralysis, were found unsuitable for this operative technique. Average disability in compensation cases was 7·3 per cent for the whole series. *Mr A. D. Polonsky* favoured division of the subscapularis and overlapping in repair and advised immobilisation for three to five weeks. He had no personal experience of the new approach. *Professor Bryan McFarland* favoured the more adequate exposure afforded by subscapularis division and wondered whether fixation of the glenoid rim to bone by metal staples was adequate and permanent. *Dr Henry Kessler* (Newark, U.S.A.) considered stapling to be adequate and was of the opinion that the staples completed their purpose in the first few weeks and thereafter they were " merely there " and no longer subjected to strain.

Osteotomy of femur with internal fixation in the treatment of osteoarthritis—*Mr T. B. McMurray* (Cape Town) contended that both the cup arthroplasty and the acrylic head replacement had failed to yield successful long-term results, and that the McMurray displacement osteotomy was superior to both methods. Prolonged immobilisation in a plaster was, however, associated with serious disadvantages, more particularly in hot climates where it became an almost prohibitive handicap. Forty-three osteotomies were fixed internally by the use of the Jewett blade-plate, in which the angle had been fixed at 150 degrees. No complication had been noted in this series, and sound bony fusion was present after three months. The use of external fixation was entirely eliminated, and the results were excellent in all cases. *Professor Bryan McFarland* did not agree that internal fixation offered any advantages over external, nor that it was desirable to aim at early mobilisation. *Mr W. T. Ross* (Johannesburg) believed that the medial displacement of the femoral shaft was of more importance than the degree of abduction, and that the osteotomy afforded the opoortunity to correct the flexion and lateral rotation deformity which so often pertained.

Instability and stabilisation of the lumbar spine, including the intervertebral disc—*Mr A. Helfet* (Cape Town) discussed the problem of when the so-called disc syndrome is associated with instability of the lumbar spine, and when should the affected joint be fused. Instability of the lumbar spine might occur in three ways: 1) Postero-anterior instability, as is seen in spondylolisthesis with or without a demonstrable defect in the pars interarticularis. 2) Flexion or "hinge" instability, usually seen in the upper lumbar spine and due to rupture of the posterior ligaments. 3) Rotational instability, usually in association with injury to the intervertebral disc and commonly in the fourth or lumbo-sacral joints. Clinically, the first and second forms were essentially bilateral lesions, whereas the third was unilateral. Symptoms and signs of the three types were different. Lateral views, taken in flexion and extension, were helpful in diagnosis. Demonstrable spinal instability of any one of these three types was an indication for spinal fusion. *Mr G. T. du Toit* (Johannesburg) preferred spinal fusion only when removal of a disc through the interlaminar approach failed to bring relief from pain. *Mr K. Lewer Allen* (Johannesburg) was convinced that the cause of root pain was in the nature of something far more subtle, and favoured the theory of an intermittent ischaemia of the nerve roots brought about by intermittent stimulation of the sympathetic fibres of the cord. He felt that the danger of Mr Helfet's contention was that the diagnosis of the level of the lesion was entirely radiological, whereas it should be largely clinical. *Mr Helfet*, replying, pointed out that Mr Allen had misunderstood, as the picture he had painted of these conditions was essentially clinical, the clinical signs being emphasised. But the radiological findings were a definite confirmation.

AUSTRALIA

AUSTRALIAN ORTHOPAEDIC ASSOCIATION

ANNUAL GENERAL MEETING

The meeting was held in Sydney on August 12 and 13, 1955, and was attended by about seventy-five members. The following office-bearers were elected for the year 1955–56. *President*, Mr Tom King (Melbourne); *president elect*, Mr A. R. Hamilton (Sydney); *vice-presidents*, Mr A. L. Dawkins (Perth), Mr J. Lahz (Brisbane), Mr D. Parker (Hobart) and Mr Neville Wilson (Adelaide);

honorary secretary, Mr F. McC. Callow (Sydney); *honorary treasurer*, Mr W. Hugh Smith (Sydney); *honorary editorial secretary*, Mr W. S. L. Stening (Sydney); *Committee*, Mr W. L. MacDonald (Sydney), Mr L. Teece (Sydney), Mr C. D. Langton (Sydney) and Mr Carlyle Hudson (Sydney).

SCIENTIFIC MEETING

Papers were presented on Friday, August 12. The Presidential Address on " The Structure of the Intervertebral Disc and its Relation to Unstable Lumbar Vertebra " was given by Mr Tom King (Melbourne).

Fat embolism—*Professor R. I. Harris* (Toronto) stated that in most fractures of the long bones fat entered the circulation. This presented two questions: 1) Why does liquid fat cause blockage of capillaries and irritation? 2) Why do small amounts of fat cause severe reaction and death in some cases? (Experimentally to produce symptoms requires more fat than exists in the whole femur.) He described several syndromes: 1) pulmonary syndrome—fever, pain, cough and radiological changes; 2) sudden death, usually cardiac; 3) cerebral syndrome—semi-coma, confusion, restlessness with sometimes pulmonary signs and skin petechiae: there might be complete recovery or, infrequently, permanent cerebral dysfunction; 4) haemorrhagic exudate in the lungs, with consolidation and rapidly falling haemoglobin and red blood cell count. He said that there was no known specific treatment. Recently his team had been experimenting with the use of detergents, at present unsuccessfully. *Mr A. Dwyer* (Sydney) asked the value of ligation of the deep femoral vein in prevention. *Professor Harris* said none. *Mr E. Spring* (Melbourne) described a case following arthrodesis of the knee for rheumatoid arthritis; necropsy revealed very little urine in the bladder. *Professor Harris* had never seen renal failure from fat embolism. *Mr W. D. Sturrock* (Sydney) mentioned fat embolism after operation for compound fracture of the leg; fat emboli were visible in retinal vessels. *Professor Harris* said examination of the eye grounds should form part of the examination. *Mr A. Watts* (Sydney) asked whether fat could be extra-osseous in origin. *Professor Harris* said that there was evidence of fat embolism after trauma to subcutaneous fat.

The altered appearance of bone in rheumatoid arthritis in relation to increased possibility of embolism—*Mr L. Woodland* (Sydney) and *Mr J. Gallagher* (Brisbane) read a paper on this subject.

Carpal injuries—*Mr J. Jens* (Melbourne) advocated primary excision in many cases of severe distortion in fractures of the scaphoid, or of fracture-dislocation of the wrist, and quoted satisfactory results. He pointed out the importance of special radiological views of the carpus in detecting some fractures, particularly of the scaphoid and associated fractures in other carpal bones often missed by usual techniques of radiography. He also mentioned the usefulness of arthrographs. *Mr H. Barry* (Sydney) thought present radiographic techniques satisfactory and did not think that arthrographs helped. *Professor R. I. Harris* (Toronto) preferred fusion or styloidectomy to excision of the scaphoid or lunate bone. *Mr J. Lahz* (Brisbane) mentioned good results of excision of lunate (one case) and scaphoid (two cases); his worst results were from styloidectomy. *Mr F. Callow* (Sydney) said that occupation was the important consideration. *Mr W. Pannell* (Perth) and *Mr T. King* (Melbourne) spoke against primary excision. *Mr Jens*, in reply, said that excision had a very real place in severe carpal injuries.

Acute osteomyelitis in children—*Mr W. Gilmour* (Perth) contrasted the present position in Perth with that in 1946 when *Mr R. McKellar Hall* (Perth) demonstrated how penicillin had virtually caused the disappearance of operative treatment and chronic sequelae in this disease. The position now was virtually the same as it had been before the advent of penicillin. Since 1950 there had been: 1) a new insurgence of the disease, due to increased prevalence and changing character of the staphylococcus; 2) an increase in young children, particularly in the first year of life; and 3) an increased severity of the disease. He advocated a return to early decompression by multiple drill holes. *Mr L. Teece* (Sydney) spoke of the futility of giving penicillin empirically or operating under a " penicillin cover." *Mr A. Rhydderch* (Sydney) asked what antibiotics were the organisms sensitive to. *Mr B. Keon Cohen* (Melbourne) was interested in the high increase in the first few weeks of life, and mentioned the danger of obstetric hospital nursing. *Mr A. Armstrong* (Wollongong) also mentioned the relation to maternity hospitals, and asked if any investigations were made in this respect. *Mr J. Colquhoun* (Melbourne) said that Winnett-Orr treatment still had its place, and that antibiotics were still a good weapon if used intelligently. *Mr E. Spring* (Melbourne) asked if a mechanical or electric drill was used at operation, as an electric drill could cause ring sequestra. *Professor R. I. Harris* (Toronto) was startled to learn of the good health of the staphylococcal community. He said that in Canada sulphonamides were usually combined with antibiotics. *Mr D. Parker* (Hobart) spoke against early operation. *Mr L. MacDonald* (Sydney) said that there was difficulty of diagnosis in young infants. He did not like early operation and thought antibiotics were still very useful.

CLINICAL CASES

Clinical cases were presented at Sydney Hospital on Saturday, August 13, 1955.

Vertebral fracture in Hodgkin's disease—*Mr W. Stening* (Sydney) presented a case of generalised Hodgkin's disease in a woman aged thirty-two with pathological fracture through the pedicles of the third lumbar vertebra and gross rotation of the vertebral body, treated by fixation of the second, third and fourth lumbar vertebrae with a Vitallium plate.

Osteochondritis of vertebra and hip—*Mr W. Stening* (Sydney) presented a girl of thirteen with osteochondritis of the ninth thoracic vertebra and of the central cartilage of the acetabulum, with protrusio acetabuli.

Failure of Vitallium cup arthroplasty and Vitallium prosthesis arthroplasty—*Mr L. Teece* (Sydney) presented a case with dislocation of the prosthesis and chronic infection. In discussion various suggestions were offered: *Professor R. I. Harris* (Toronto) recommended abduction arthrodesis and later osteotomy. *Mr H. Barry* (Sydney), *Mr T. King* (Melbourne) and *Mr D. Parker* (Hobart) were of the same opinion with some modifications. *Mr R. Hodgkinson* (Sydney) recommended excision of the femoral head and osteotomy. *Mr J. Lahz* (Brisbane) recommended removal of the prosthesis alone.

Salvage operation on the hip—*Mr C. M. Maxwell* (Sydney) demonstrated three cases: 1) Old bilateral Perthes' disease unrelieved by osteotomy but successfully treated by bilateral arthroplasty with Judet's prosthesis. 2) Right Perthes' disease with osteoarthritis; Vitallium cup arthroplasty later complicated by fractures of the femur and tibia; good relief after insertion of Austin Moore prosthesis. 3) Bilateral osteoarthritis treated by Judet type procedure; fracture of left prosthesis after thirteen months; replacement; fracture of neck of left femur six months later; replacement by Austin Moore prosthesis. *Professor R. I. Harris* (Toronto) preferred a prosthesis with a stem extending down the medullary cavity.

Pathological fracture of the left upper humerus from secondary carcinoma of renal origin—*Mr F. H. M. Callow* (Sydney) showed a patient treated by left radical nephrectomy and later left interscapulo-thoracic amputation. *Mr A. Dwyer* (Sydney), *Mr F. Stonham* (Melbourne) and *Mr W. D. Sturrock* (Sydney) described similar cases.

Calcification near the lateral epicondyle of the humerus—*Mr N. J. Royle* (Sydney) presented two cases and discussed pathology and treatment. *Mr R. Wherrett* (Sydney), *Mr P. Williams* (Melbourne), *Mr A. Dwyer* (Sydney) and *Mr A. McSweeney* (Brisbane) described cases in their recent experience. *Professor R. I. Harris* (Toronto) thought all these cases were akin to the similar condition in the shoulder. The essential principle was to remove tension.

Quadricepsplasty for post-traumatic stiffness of the knee—*Mr W. D. Sturrock* (Sydney) presented three cases demonstrating the late results and briefly described the operative technique, selection of cases and after-care. Discussion was confined to admiration of the results.

Fracture of the pelvis with damage to the sciatic nerve—*Mr A. I. Rhydderch* (Sydney) presented a case of crushing injury, in which at operation it was found that a displaced splinter of bone was transfixing the sciatic nerve; removal led to complete loss of severe pain but damage to the nerve appeared permanent. Discussion was on the best operative approach to the sciatic nerve in the buttock.

Banked bone—*Mr K. Daymond* (Sydney) showed seven cases from Sydney Hospital illustrating the important role of the bone bank in massive lesions or where previous fusion had been attempted.

On Monday, August 15, 1955, a Clinical Meeting was held at St Vincent's Hospital, Sydney.

Congenital anomaly of the foot—*Mr A. Hamilton* (Sydney) demonstrated a child with multiple lesions and mild hydrocephalus; amputation of the sixth toe and metatarsoplasty had been performed; later, lengthening of the calcaneal tendon was contemplated.

Albers-Schönberg disease—*Mr A. Watts* (Sydney) showed a case of a child aged five with Albers-Schönberg disease and fracture of the neck of the femur; other siblings were affected with the same disease. *Mr H. Barry* (Sydney) asked the cause, prognosis and treatment. *Mr Watts* said that it was a recessive inherited disease, static after bone growth ceased. *Mr W. Hugh Smith* (Sydney) describing three cases, emphasised the difficulty of operating on these cases, the bone being so hard that it would bend an osteotome. *Professor R. I. Harris* (Toronto), who had never seen a case, reasoned that inherited diseases were common in some countries because of " islands " of affected families, instancing alkaptonuria in Yugoslavia, and club feet and slipped femoral epiphysis in New Zealand.

Two unusual dislocations—*Mr A. Armstrong* (Wollongong) described: 1) Antero-lateral dislocation of head of ulna due to forced supination of wrist in a rugby tackle; and 2) posterior dislocation of the shoulder during shock therapy. *Mr W. Stening* (Sydney) described an identical case of dislocated ulna also sustained in a tackle at rugby football and two cases of posterior dislocation of shoulder occurring during shock therapy. *Mr B. Keon Cohen* (Melbourne) and *Mr L. Teece* (Sydney) described

cases of posterior dislocation of the shoulder and their method of treatment. *Mr A. Dwyer* (Sydney), *Mr S. Scougall* (Sydney), *Mr L. Woodland* (Sydney) and *Mr T. King* (Melbourne) described cases in their practice and their methods of immobilisation and reduction.

Leg lengthening—*Mr G. McKellar* (Sydney) showed a case in which he had gained three inches in a leg four inches short and proposed supracondylar osteotomy to correct varus deformity from defective epiphysial growth. *Professor R. I. Harris* (Toronto) stressed the difficulty of lengthening procedures. *Mr G. Colvin* (Sydney) preferred lengthening through the tibia, rather than the femur as in this case.

Prosthetic replacement of the femoral head combined with osteotomy—*Mr S. Scougall* (Sydney) presented three cases illustrating a new principle in the operative treatment of osteoarthritis of the hip, a combination of replacement of the femoral head and osteotomy, which he called the keylock arthroplasty. This had been carried out, both parts simultaneously, in eleven patients with osteoarthritis of the hip. A slightly valgus position of the Vitallium prosthesis, if necessary exaggerated by wedge osteotomy, rendered it stable with a short pin of two inches, which left a large area of intact bone for retention of the position after osteotomy by a plate locking into the trochanter by a keyway (Figs. 1 and 2). From a review of the eleven patients the early results suggested the same reliability

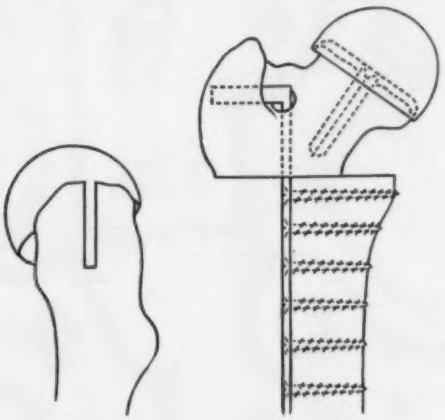

FIG. 1 FIG. 2

Keylock arthroplasty of the hip by combined replacement of the femoral head and femoral osteotomy with internal fixation. Figure 1—Slot cut in the greater trochanter to form part of the keyway for the locking plate. Figure 2—Diagram of the completed operation.

in relief from pain as is obtained by femoral osteotomy alone, and the same range of movement as is obtained by replacement of the head. In addition, the results indicated a speedier rehabilitation, possibly because of freedom from pain. Either procedure could be used separately, the other following later. The combined procedure might be used when the aim was movement and freedom from pain rather than the maximum power required by the young labourer.

Arthrodesis of the shoulder—*Mr A. Dwyer* (Sydney) described a method of arthrodesis of the shoulder. A figure-of-eight wire was introduced binding the head of the humerus to the scapula with the effect of compressing the humeral head against the glenoid surface by the weight of the abducted arm. He described arthrodesis well advanced after six weeks.

Pathological fracture of the humerus—*Mr W. Hugh Smith* (Sydney) presented a woman aged forty with pathological fracture through a cyst in the upper third of the humerus. Operation revealed the cyst to be an angioma, which healed after the insertion of bone chips. *Professor R. I. Harris* (Toronto) said that the radiograph suggested an aneurysmal bone cyst described by Jaffe and Lichtenstein.

Reticulosarcoma—*Mr J. Roarty* (Sydney) presented a boy aged eighteen with reticulosis of bone affecting three lumbar vertebrae and the sternum. Biopsy diagnosis was a reticulum cell sarcoma.

Scientific papers were presented on Monday afternoon, August 15, 1955.

OTHER PAPERS

Congenital dislocation of the hip—*Mr A. McSweeney* (Brisbane) had surveyed forty unselected cases of congenital dislocation of the hip in which treatment had been at least five years ago. Early treatment by closed methods gave the best results. The best results were those in which plaster immobilisation was followed by splinting of Denis Browne type. The results of open reduction and Colonna's operation were disappointing. The results of shelf operation were only fair. The functional result in adult life was usually superior to the anatomical appearance. *Mr J. Critchley* (Melbourne) considered that arthrograms were important to distinguish subluxations from dislocations, and that an angle of anteversion greater than 35 degrees called for subtrochanteric osteotomy. *Mr A. Meehan* (Brisbane) said that in shelf operation the shelf always absorbed unless made before the age of ten. He and *Mr A. Hamilton* (Sydney) mentioned bad results from Colonna's operation. *Mr R. McGlynn* (Sydney) recalled that the age when treatment began was most important.

Homogenous bone grafting—*Mr D. Parker* (Hobart) referred to sources of bone and methods of storage. He described the use of stored bone in twenty-four cases in which there were no wound complications, and analysed six failures. He stressed that the graft must be firmly opposed and immobilised. Stored bone was disappointing in spine grafting, but was particularly useful in filling large defects. *Professor R. I. Harris* (Toronto), from his experience in six or seven years, considered homogenous bone less effective than autogenous. *Mr P. Williams* (Melbourne) had tried boiled cadaveric bone in three cases for spinal fusion without success. *Mr A. Dwyer* (Sydney) had used fresh cadaveric bone. *Mr J. Cloke* (Melbourne) considered boiled or autoclaved bone useless, and said that after one week it could be powdered in the hand.

Osteotomy of the hip with spline fixation—*Mr R. Hodgkinson* (Sydney) described various forms of arthroplasty and prosthesis and their limitations and complications. He then discussed displacement osteotomy and internal fixation with a spline screwed to the upper femoral shaft. He gave the case histories of five patients in which this technique was adopted. He thought the operation had its main applications in middle age. *Mr A. Meehan* (Brisbane) opened the discussion by presenting the follow-up of fifty-four patients in whom McMurray osteotomy had been performed during the last eighteen years. Thirty-five of the fifty-four had replied to his questionnaire. Of these, twenty-one (60 per cent) showed great improvement, and only three (8 per cent) were worse. Pain was abolished in seventeen (49 per cent), decreased in twelve (34 per cent) and worse in four (11 per cent). All the patients were pleased with operation except two. *Mr T. King* (Melbourne) considered the operation suitable only for unilateral osteoarthritis.

Recurrent dislocation of the ankle—*Mr F. Stonham* (Melbourne) discussed diagnosis and treatment under three headings: prophylactic, non-operative and operative. The operation he employed and recommended was a modification of the Watson-Jones procedure using the peroneus brevis tendon to reinforce the lateral ligament of the ankle. *Professor R. I. Harris* (Toronto) thought there was often a congenital structural weakness. *Mr B. Keon Cohen* (Melbourne) spoke against early movement after operation or injury. *Mr J. Lahz* (Brisbane) said that this operation abolished rotary movement of the ankle.

ROYAL AUSTRALASIAN COLLEGE OF SURGEONS

A General Scientific Meeting was held in Sydney on August 16–19, 1955.

Injuries of the hand—*Mr A. R. Wakefield* (Melbourne), confining himself to tendon injuries, considered that all severed tendons should be sutured primarily unless: 1) both tendons were divided in the proximal part of the finger; 2) profundus alone was divided in this area; 3) primary suture was contra-indicated for some other general condition. He mentioned causes of failure in tendon suture: 1) faults in operative technique, for instance unsuitable instruments and lack of technical training; 2) thickened paratendon not removed at secondary suture; 3) retention of contracted pulleys instead of removal of entire sheath; 4) misjudgment of proper tension of the tendon; 5) faulty after-care. Adequate immobilisation for three weeks, and adequate supervision after the splint was removed were most important. *Mr D. Officer Brown* (Sydney) presented cases illustrating plastic repair in skin loss, contractures and severed tendons in the hand. *Mr D. Parker* (Hobart) stressed the importance of a physiological position of rest for injured joints, and also mentioned internal fixation of fractures to allow early movement.

Treatment of fractures of long bones by intramedullary fixation—*Mr P. Williams* (Hobart) discussed the indications, operative procedure and difficulties, complications and results of this operation. Discussion was widespread and was largely concerned with the difficulties and complications of the operation, several speakers mentioning the special difficulties in Paget's disease.

Structural changes in lumbo-sacral spine: relationship to low back pain and sciatica—*Professor R. I. Harris* (Toronto) was mainly concerned with pathological anatomy of the low back. He discussed the effect of certain metabolic diseases—for instance alkaptonuria, on the disc. He showed radiographs and necropsy specimens indicating the pathology of disc injury and its relation to mechanics at the apophysial joints and ligaments. He particularly emphasised that ligamentous injuries and internal derangements of intervertebral joints contributed much to the causation of chronic low back pain.
Denervation of the knee for osteoarthritis—*Mr O. W. Leitch* (Adelaide) described the surgical anatomy and operative approach to the articular nerves, and emphasised that all must be divided. So far, his results were most satisfactory in permanently abolishing pain without consequent arthropathy.

THE AUSTRALASIAN MEDICAL CONGRESS (BRITISH MEDICAL ASSOCIATION)

The congress was held in Sydney from August 20–27, 1955.
Some observations on the treatment of fractures—*Mr E. West* (Adelaide), president of the Orthopaedic Section, discussed in his Presidential Address the principles and the modern approach to fracture treatment. The dangers of unpadded, unsplit plasters in the initial immobilisation of fractures were stressed by the speaker and emphasised in the discussion.
Denervation in osteoarthritis—*Mr O. W. Leitch* (Adelaide) discussed this procedure in relation to hip, elbow and ankle in addition to the knee.
Medical aspects of osteoarthritis of the hip—*Dr Michael Kelly* (Melbourne) read a paper on this subject.
Surgical relief of pain in osteoarthritis of the hip—*Mr J. Hoets* (Sydney) indicated the relative position of osteotomy, arthrodesis and arthroplasty. He discussed the various types of arthroplasty. He thought the Smith-Petersen operation had given the best results so far, but they were unpredictable. He mentioned the disadvantages and advantages of the other forms of arthroplasty employing replacement prostheses.
Sudeck's atrophy—*Mr A. Dwyer* (Sydney) discussed the physiology and clinical picture. In treatment he suggested that greater vasodilation should be aimed at. Active exercise was particularly necessary. Cortisone was of benefit when burning pain was a feature.
The use and abuse of plasters—*Mr H. Barry* (Sydney) emphasised the circulatory dangers of misuse.
Fractures round the elbow—*Mr B. Keon Cohen* (Melbourne) read a paper.
Fractures of the calcaneum—*Mr F. Callow* (Sydney), describing this as the unsolved fracture, pointed out that the trouble lay with the subtalar joint, and advocated its obliteration by primary arthrodesis if much involved.
Low back pain—*Mr B. McKellar-Hall* (Perth) and *Mr W. Hugh Smith* (Sydney) both presented papers strongly emphasising that the intervertebral disc was often unjustly blamed for low back pain often caused by other simpler conditions. Both indicated that mention to a patient of a disc injury, or anything including the word disc, should be avoided as causing considerable psychological damage. Discussion was prolonged. There was general agreement that the results of intervertebral disc surgery on the whole were disappointing.
Ankylosing spondylitis—*Mr K. Daymond* (Sydney) and *Professor B. Windeyer* (London) mentioned the importance of early diagnosis, the different clinical syndromes, the differential diagnosis and the good results of deep x-ray therapy combined with adequate physiotherapy. Mr Daymond particularly stressed the advantages of carrying out the initial stages of this treatment while the patient was still in hospital.

THE BRISBANE TRAGEDY

Surgeons everywhere were shocked to learn of the attack made by a madman in Brisbane on Michael Gallagher, Arthur Meehan, Andrew Russell Murray and John Lahz, causing the serious wounding of Gallagher and the death of Meehan and Murray. Members of the British Editorial Board of this Journal were gathered at the Royal College of Surgeons of Edinburgh for a meeting of the Board when the news reached them. A message was cabled at once to Tom King, president of the Australian Orthopaedic Association, expressing the grief of fellows and members of the British Orthopaedic Association and of members of the British Editorial Board, and conveying deep sympathy with those who were anxious, had been injured, or were bereaved. The surgeons who had been the victims of this assault were well known in the United Kingdom, where each had many friends. The sense of loss and dismay felt in their own city, state and country is shared in London, Liverpool, Edinburgh and elsewhere at home.

Because of several unreliable press statements (for instance that both hands of a passer-by had been blown off whereas in fact he had lost two fingers) we think it right to publish a dependable account for which we are principally indebted to J. R. S. Lahz himself. A post-war immigrant from

Central Europe, Karl Kast by name, had sought compensation for backache and been refused certificates of incapacity by various orthopaedic surgeons including those who were attacked. Armed with home-made bombs and a loaded ·38 service revolver he entered Michael Gallagher's consulting room and in the presence of a girl patient and her mother shot three bullets, critically wounding him in the lung, wrist and leg. After reloading the revolver and letting off a bomb in the building, the murderer carted a valise of bombs one hundred yards down the street to Ballow Chambers where he placed them in the waiting room of Mr Lahz. Going downstairs he shot Arthur Meehan in the chest, and then he found Murray examining a patient and shot him in the abdomen. Thence the killer went to Lahz's suite on the same floor, where in the waiting room he picked up his bombs, covered the patients with a pistol, and amid cries of " murder " was met by the surgeon who was pushed back at pistol point into the office, through another room to an examination room where his secretary and nurse, although repeatedly told by the murderer to get out, stood loyal and stalwart. In moving from the second to the third room they succeeded in closing a door between the intended victim and the murderer. The madman barricaded himself in the consulting room, which he wrecked by scattered bombs, and then with his pistol blew out his own brains.

It should be added that just before starting on this murderous performance Karl Kast had posted a letter to the Australian police in which he outlined an even more numerous assault and referred in some detail to the murder of Rex Hylton of Toronto by a claimant to Workmen's Compensation, who died in similar tragic circumstances.

Arthur Meehan loved this passage from Macbeth, and his nurse found it on his desk cut from a book: " Canst thou not minister to a mind diseased; Pluck from the memory a rooted sorrow; Raze out the written troubles of the brain."

NEW ZEALAND

NEW ZEALAND ORTHOPAEDIC ASSOCIATION

1955 MEETING

The annual meeting of the New Zealand Orthopaedic Association was held at the Wellington Hospital from July 25–28, 1955, under the presidency of Mr Morris Axford.

The president extended a warm welcome to the Sims Visiting Professor for 1955, Professor R. I. Harris of Toronto.

Spondylolisthesis—*Professor R. I. Harris* (Toronto) stated that two surveys carried out in Toronto and Cleveland showed that 5 per cent of the population were affected. In Alaskan Eskimos the incidence was 30 per cent. The condition did not seem to be present at birth and developed in early life. Low backache and sciatica were the chief symptoms and the onset was often associated with injury. The defect in the pars interarticularis was not as great as the forward slip of the vertebral body. He advocated spinal fusion as the treatment of choice in young patients and in older patients if conservative treatment had failed. His own preference was for two tibial grafts fixed securely with heavy stainless steel wire and supplemented by large quantities of cancellous bone. He was not in favour of removing the neural arch alone as this did not stabilise the slipping spine. *Mr A. Macdonald* (Auckland) and *Mr A. B. Mackenzie* (Christchurch) both thought that in spondylolisthesis the disc protruded forwards. Neither had seen it at operation.

Intramedullary nailing—*Mr Harman Smith* (Auckland) reviewed fifty-two cases from the Middlemore Hospital, including forty-two cases of fracture of the shaft of the femur. The ideal case was one in which the fracture line was transverse with some irregularity for locking. He stressed the importance of using a nail of correct width. He advocated reaming of the medullary cavity of both fragments before inserting the nail over a guide wire. The nail should not protrude more than half an inch above the trochanter. Further protrusion had caused pain in the gluteal muscles and in one case a calcified bursa. Knee movement did not return fully until the fracture was united. Intramedullary nailing in Paget's disease was advocated. All Mr Smith's cases of fracture of the humerus showed limitation of shoulder movement from the injury to the rotator cuff. *Professor R. I. Harris* (Toronto) stressed the great value of intramedullary nailing in ununited fracture of the femur.

Recurrent dislocation of the shoulder—*Mr A. B. Mackenzie* (Christchurch) reported eleven cases treated by the Putti-Platt operation without recurrence. He thought that whatever technique was used it should repair or buttress the defect in the capsule and should limit lateral rotation of the shoulder. He advocated an operation field rendered bloodless by the local injection of adrenalin solution. Both he and *Mr J. Kennedy Elliott* (Wellington) agreed that the lesion was not always as described by Bankart. *Mr Alan Alldred* (Dunedin) advocated a more cosmetic incision for women.

Tuberculous osteitis pubis—*Mr J. R. Kirker* (Auckland) reported six cases collected between 1949 and 1954. The two presenting features were disturbance of gait and abscess formation. He had reviewed the literature and thought the condition to be more common than was suggested. He advocated wide excision of the symphysis at an early stage with antibiotic protection. Conservative treatment often failed, as did attempted bone grafting. All six patients were treated surgically with success. *Mr H. Walden Fitzgerald* (Dunedin) supported surgical excision and reported a successful case.

Slipped upper femoral epiphysis—*Mr R. H. Dawson* (Palmerston North) reviewed nineteen cases involving twenty-two hips. He thought these emphasised the relatively narrow age incidence of ten to thirteen in girls and thirteen to sixteen in boys. Avascular necrosis of the femoral head developed in two patients after prolonged bed rest with traction. He advocated Smith-Petersen nailing in cases of early slipping, and of more marked slipping if seen early and reducible by gentle manipulation. Wedge osteotomy of the neck was unsatisfactory: avascular necrosis occurred in five of his seven cases. If correction was desirable it could be achieved by cuneiform osteotomy at the level of the trochanters. *Professor R. I. Harris* (Toronto) showed slides of experimental work carried out on the femoral heads of dogs. These emphasised that, if the femoral neck were divided at a level comparable with that of slipped epiphysis in humans, it was essential to hold cancellous bone securely against cancellous bone to prevent avascular necrosis.

Haemarthrosis of the knee—*Mr W. A. Liddell* (Wellington) reported two unusual cases. A seven year old boy had suffered repeated effusions in the right knee for four years. A very slight injury was sufficient to cause swelling. Aspiration of a heavily bloodstained fluid suggested a haemangioma of the synovial membrane. Investigation of the blood showed no abnormality and an arteriorgam was normal. Exploration revealed a haemangioma adjacent to the medial condyle of the femur. The haemangioma was removed and he made a satisfactory recovery. A fifty-two year old man had a swollen knee after a slight twist. He reported four previous incidents with severe pain and moderate swelling. He had noticed a lump on the outer side of the patella. Examination revealed an effusion, with tenderness and oedema on either side of the patellar ligament. Aspiration produced 60 cubic centimetres of bloodstained fluid. Exploration revealed a pedunculated tumour attached to the infrapatellar pad of fat. The suprapatellar pouch contained a large chicken fat clot. Sections of the tumour suggested that it was a degenerating lipoma. Recovery was complete in three months.

Parosteal osteoma—*Mr J. W. Saunders* (Wellington) reported two cases which he thought exemplified this tumour. A thirty-five year old man complained of a painful swollen knee for five weeks. Examination revealed an effusion and a firm tender tumour, two inches in diameter, overlying the lateral femoral condyle. Radiographs revealed a tumour containing small discrete areas of calcification. Exploration showed that the tumour was firmly adherent to the femur adjacent to the suprapatellar pouch of the knee. Sections of the biopsy material showed a fibrocartilagenous structure with areas of osteoid tissue. In some areas the cells showed evidence of malignancy. Amputation was carried out and the patient remained well three and a half years later. A thirty-six year old woman complained of a dull ache at the back of her knee. A lump was noticed. After biopsy she was advised that she need have no concern. Twelve months later the pain increased and she was admitted for investigation. Examination revealed a smooth bony mass in the popliteal fossa firmly attached to the femur. Radiographs showed new bone in the soft tissues around the lower femur to which it was attached. There was no obvious pedicle, and no periosteal reaction. The tumour had a lobulated appearance. Arteriograms revealed its highly vascular state and suggested malignancy. Biopsy was inconclusive but the sections suggested a benign lesion. Amputation was carried out. A review of the literature suggested that amputation was the treatment of choice.

Syme's amputation—*Professor R. I. Harris* (Toronto) said that the two major functions of the lower limb, weight bearing and propulsion, were provided by amputation at the ankle. He thought that the divergence of opinion between Canadian and European surgeons could be explained only by different technique and management. He stressed the three essentials as being 1) division of the tibia at the level of its greatest cross-section, 2) even distribution of weight on this area, 3) a covering of skin accustomed to bearing weight. He thought that preservation of the loculi of fat in the heel flap was vital. He recommended that the technique described by Syme be followed in detail. He pointed out that the unsightly prosthesis made this amputation less suitable for women than for men. *Mr A. Macdonald* (Auckland) and *Mr H. Walden Fitzgerald* (Dunedin) both spoke in favour of Syme's amputation.

Lipoid histiocytosis—*Dr J. O. Mercer* and *Dr J. D. Reid* (Wellington), introduced by Mr Morris Axford, said that histological sections in Hans-Schüller-Christian's disease, Letterer's syndrome and eosinophilic granuloma showed the presence of histiocytes, eosinophils and later fibrosis. It was not possible to distinguish them histologically, and the speakers had been unable to correlate the clinical and histological pictures. They described four cases showing the different features. *Mr Harman Smith* (Auckland) described two further cases.

Multiple metaphysial fractures—*Mr G. M. Goodson* (Lower Hutt) said that a baby of ten and a half months was brought with a fracture of the upper end of the left humerus. In subsequent films abundant callus was seen but the head of the humerus appeared to move on the shaft. A similar appearance was noted at the upper end of the right femur and in all the metaphyses adjacent to the knees The Wassermann reaction was normal. The lesions healed after eight weeks' gallows traction. *Mr Coates Milsom* (Tauranga) said that the radiographic appearances differed from those that he had seen in scurvy.

Hallux valgus—*Professor R. I. Harris* (Toronto) said that the accepted operations for this deformity were not entirely satisfactory. The drawback of the Keller operation was the loss of function of the great toe. He described an operation which, although lengthy, restored function and corrected deformity. The following were the steps: a dorsal incision, removal of the exostosis, a corrective osteotomy of the first metatarsal with internal fixation by wire, detachment of the adductor and its transplant through a hole in the head of the first metatarsal. Post-operative fixation with plaster was continued for four weeks.

Lesions of the ischio-pubic ramus—*Mr J. Kennedy Elliott* (Wellington) described two cases of children who came with pain in the ischio-pubic ramus and a limp. Radiographs revealed an area of rarefaction which healed in less than three months. Mr Elliott considered the condition to be a type of osteochondritis.

Yeast infections of joints—*Mr B. M. Hay* (Hamilton) described two cases. A young woman with generalised tuberculosis developed an atypical lesion of an ankle. Pus found at exploration grew the yeast Cryptococcus neoformans. There was no histological evidence of tuberculosis. A woman with sarcoidosis developed a swollen knee. Aspiration showed no tubercle bacilli, but pus cells and a yeast were found. Subsequent aspirations showed the same yeast, which was not identified. *Professor R. I. Harris* (Toronto) said that his patients were nearly all inmates of sanatoria. He pointed out the necessity for proving the nature of the patient's disease whenever possible by identifying the organism.

Longitudinal plaster technique—*Dr T. L. Parr* (Masterton) described a method of applying casts by running the bandages along the length of a limb in preference to circular turns. He had devised a simple tool to carry the standard bandages. He claimed that the casts were stronger and lighter and could be applied with the limb resting on a pillow.

Arthroplasty of the shoulders—*Mr H. K. Christie* (Wanganui) described the follow-up of a case of arthroplasty of the shoulder.

Travel—*Mr H. Walden Fitzgerald* (Dunedin) spoke of his experiences on a recent trip overseas.

AUSTRIA

AUSTRIAN ORTHOPAEDIC SOCIETY

Professor Walther Ehalt, our Corresponding Editor for Austria, reports that at the general meeting in December 1954 Hofrat Dr Schosserer was elected as president of the Austrian Orthopaedic Society. There were four scientific meetings with the following main subjects: spondylitis, artificial limbs, intervertebral discs, tumours of bone.

In May 1955 the annual meeting was held at Klagenfurt-Caryntia, with the Society of Traumatology and the Society of Physical Medicine. The main subjects were poliomyelitis and fractures of the spine (without lesions of the cord). A film was shown of orthopaedic gymnastics.

In October 1955 an International Conference was held in Vienna (director Professor Dr P. Erlacher) and in Graz (director Professor Dr W. Ehalt). This was arranged through the United Nations, the World Veterans' Federation and the International Labour Office. The subject for discussion was the rehabilitation of the disabled in Austria. Representatives of fourteen nations were present. The guest speaker was Mr L. Guttmann from Stoke Mandeville, England.

Book Reviews

MODERN TRENDS IN ORTHOPAEDICS (Second Series). Edited by Sir Harry PLATT, LL.D., M.D., M.S., F.R.C.S., F.A.C.S., President, Royal College of Surgeons of England; Emeritus Professor of Orthopaedic Surgery, University of Manchester; Consultant Adviser in Orthopaedic Surgery, Ministry of Health; Honorary President, Société Internationale de Chirurgie Orthopédique et de Traumatologie. With ten other contributors. 10×7 in. Pp. ix+331, with 226 figures. Index. 1956. London: Butterworth & Co. (Publishers) Ltd. Price 65s.

This is not a second edition. It is a new volume, and the appetite is whetted by a summary glance at its contents.

The book illustrates the difference between consultants and specialists. Eleven orthopaedic consultants have here been treated as specialists and have been invited to write on subjects about which they know all there is to know. And that is the stuff we want to read. Credit is therefore first due to the editor for his choice of contributors. But we owe him further thanks, for, although in the first series he was a non-playing captain, in this series he has put himself in to bat on the sticky wicket of congenital dislocation of the hip. After doing 128 open operations Sir Harry Platt is not ashamed to record that he is often puzzled by what he sees. His own results make him favour closed reduction as a first choice even when subsequently open operation may prove necessary.

Capener ends an excellent judicial enquiry into reconstructive surgery of the hip thus: "the surgeon has not yet succeeded by any reliable or durable means in using purely mechanical devices as substitutes for living tissues in the body under conditions of mechanical stress." He goes on to state: "The ultimate achievement will be by some perfection of biomechanical synthesis." But there's the rub; is biomechanical synthesis possible?

To our knowledge of the surgery of peripheral nerves the last war added three items. Roland Barnes refers to two of them—the futility of suturing nerves under tension, and the value of autografts for bridging gaps. The third he also mentions, but modesty perhaps prevented him from emphasising it, namely "the value of segregating nerve injuries in centres where surgeons are available with the training and the aptitude for this exacting and often unrewarding branch of surgery." To one who had been taught by the 1914-18 war that nerves regenerated at the rate of a centimetre a week it was startling to read that a motor nerve recovered at the rate of one and a half centimetres a day, and it was reassuring to find the slip corrected twice later.

Dobson shows how streptomycin has revolutionised the treatment of bone-and-joint tuberculosis. Antibiotics have halved the period of rest, they cause local foci to heal before the tubercle bacilli are entrenched and before articular surfaces have been irretrievably damaged, they dry up sinuses of many years' standing, and they have allowed surgeons to cut into the centre of the disease and remove caseous pus and sequestra.

Clark writes on tendon transplantation in infantile paralysis. In an article remarkable for its brevity and clarity he gives the indications and the techniques for those he has found useful. His diagrams make every operation look simple.

Bonnin writing on internal derangement of the knee has had a difficult task. This is the longest chapter in the book, and considering the little that has been added to our knowledge in the last thirty years it might well have been shorter.

The modern treatment of traumatic paraplegia is succinctly stated by Holdsworth, who has had so much to do with its establishment. The immediate treatment, which follows logically once the words *spinal shock*, *spinal concussion*, *stable fracture*, and *unstable fracture* are understood, can be undertaken locally; but to prevent bed sores, to control urinary infection, to avoid deformities and to turn the patient into a useful and contented citizen, the sooner he is transferred to a paraplegic centre, the better.

Seddon records his results in thirty-three operations for Pott's paraplegia. Three out of four patients recovered. Paraplegias of early onset fared as well as those of late onset; this is surprising in view of the supposed difference in their etiology. The two operations of costo-transversectomy and lateral decompression are described, and the infrequent indications for performing laminectomy in their stead are given.

It was disappointing to find that Scott's article on coxa vara does not shed any light on three problems: first, whether after reduction of a sudden slip it is better to delay operation for a few weeks to lessen the risk of the nail's pushing the head completely off the neck when it is inserted; second, whether the risk of correcting a coxa vara by an osteotomy through the neck of the femur is worth the risk; and third, whether hastening the onset of puberty by hormone therapy in this essentially pre-puberty condition has proved useful.

Pulvertaft in his article on contracture of the hand restricts himself to three topics: Dupuytren's contracture, for which he prefers excision of the fascia to multiple fasiotomies; Bunnell's ischaemic contracture, for which he excises the oblique fibres of the intrinsic mechanism according to Littler; and skin contractures. The relative merits of free skin flaps, Z-plasty, rotation-advancement flaps, cross-arm flaps and tube pedicles are discussed. Pulvertaft considers that capsulectomy and arthroplasty are occasionally of value for a stiff knuckle joint but not for an interphalangeal joint.

Gray in a thoughtful review of fractures of the neck of the femur foresees two additions to modern practice: namely, assessing the vascularity of the capital fragment at the time of nailing by radioactive phosphorus and a Geiger probe inserted into the head along a track made by a guide wire; and the substitution of a nail plate (as used for trochanteric fractures) for the simple nail. After the Smith-Petersen nail has been inserted *secundum artem* a wedge subtrochanteric osteotomy is done and the osteotomy fixed by a plate attached to the nail, the object being to reorientate the line of the fracture from the vertical to the horizontal.

The illustrations are better than those of the first volume, and this book is not unworthy to take its place alongside others in Butterworth's valuable series of "Modern Trends." For those who pay moderate surtax the cost of the book is only 16s.—George PERKINS.

CHIRURGIE RÉPARATRICE. By R. MERLE D'AUBIGNÉ and twelve other contributors. 2me Série. 11 × 7¾ in. Pp. 268, with 178 figures. 1955. Paris: Expansion Scientifique Française. Price 3,900 fr.

That Professor Merle d'Aubigné and his band of lieutenants maintain an assiduous watch on their after-results and from time to time publish their observations with admirable clarity is of course well known. In the present volume, the second of a teaching series on the subject of reconstructive surgery, a number of previous reports have been brought up to date and some new ones added. Without exception, all the fourteen chapters have been produced by the thirteen authors in a way that adds lustre to the active school of orthopaedics from which they are derived.

To begin with, Merle d'Aubigné and Postel analyse the results of arthroplasty of the hip for traumatic or arthritic lesions with the use of acrylic prostheses. They regret that some 20 to 25 per cent of cases deteriorated between the second and fifth years for quite clear reasons, but find solace in an equal number that seemed to improve mysteriously with the passage of time. "Les améliorations tardives sont dûes à l'adaptation de la Bonne Nature; il faut en remercier Dieu." They incline towards the use of a prosthesis bigger and better than the Judet model giving replacement of the whole femoral head and most of the neck, and anchored by means of a long intramedullary nail.

Ramadier next has the perennial subject of ruptured ligaments of the knee all to himself, after which Merle d'Aubigné, now paired with Lamare, discusses non-union of the tibia, a favourite topic on the Continent. And so the chapters proceed, solos and duets alternating, until one has an excellent idea of the problems of the moment at Hôpital Cochin and of the lively way they are being tackled. The book ends with three short chapters on the use of a water soluble medium for myelography, the problems of anaesthesia in the surgery of rheumatic diseases, and the primary treatment of burns.

It is all very stimulating and, at times, engagingly frank. Thus Tran Ngoc Ninh writes a really cautionary tale about the surgical treatment of Charcot joints in the lower limbs, and Postel and Lord describe vividly the discontent of a patient with arthrodesis of the shoulder in 70 degrees of abduction. Elsewhere Professor Merle d'Aubigné and Postel record a considerable proportion of failures to obtain arthrodesis of the ankle until they adopted the fibular graft technique, but strangley enough they do not refer to the large series reported by Crawford Adams in this Journal. It is rather a pity that the short summary in English and the bibliography at the end of each chapter have not always been carefully edited.

All those who follow the rising fortunes of orthopaedic surgery in France will look forward to a third volume of equally wide interest.—K. I. NISSEN.

BODY FLUIDS IN SURGERY. By A. W. WILKINSON, Ch.M., F.R.C.S.E., Senior Lecturer in Surgery, University of Aberdeen. $8\frac{3}{4} \times 5\frac{3}{4}$ in. Pp. ix + 212, with 7 figures and 29 tables. Index. 1955. Edinburgh and London: E. & S. Livingstone Ltd. Price 16s.

For many years all surgeons, particularly those engaged in traumatic work, have recognised the importance of maintaining the blood-volume in cases of haemorrhage and shock. Similarly, in recent years it has become increasingly clear that the replacement of abnormal losses of water and electrolytes is an integral part of the care of many patients, especially those requiring abdominal surgery. It is now clear that these two aspects of treatment are not, as often implied in both thought and practice, separate entities, but just two facets of the wider problem involved in the maintenance of the equilibrium of the entire system of body fluids. Mr Wilkinson sets out to consider this problem in all its many aspects; and in its scope and comprehensiveness—compressed, none the less, to most manageable proportions—lies this book's greatest value.

In the early chapters there is a full description of the normal water and electrolyte content of the body, the effects of depletion of water and the various electrolytes, and disturbances of acid-base balance. Throughout these chapters the simple, basic facts are stressed; there is in addition much detailed biochemical information which may well be hard reading for many surgeons but which will prove of interest and value to those specifically interested in these problems. There follow chapters on the metabolic response to injury and on shock, this latter being an admirable review of the etiology, manifestations and treatment of this condition.

Disturbances due to losses of gastro-intestinal secretions are discussed and their treatment is described; this chapter includes a most useful account of the biochemical changes that may follow transplantation of the ureters into the colon, and outlines the measures to prevent such troubles. The influence of associated renal disease on fluid and electrolyte balance in surgical patients is described in some detail, and there is a particularly valuable account of the etiology of anuria, due to tubular necrosis, and its management. The final chapters are devoted to the diagnosis of electrolyte disturbances, and the control of fluid equilibrium in the normal patient undergoing surgery and in those requiring specific replacement therapy. As might be expected from this author, there is a particularly full and lucid account of the use of plasma-expanders.

Throughout the book there is emphasis on the value and importance of simple clinical observations in the management of these complex problems. Whilst discussing the intricate biochemical details Mr Wilkinson makes it clear that in most cases therapeutic success can be achieved by concentration on essential observations within the compass of all but the smallest surgical unit, and throughout he stresses the importance of not overburdening the patient by excessive investigation or treatment. Further, the author's approach to the problems is not narrowly biochemical, and in all sections of the book there is much useful general advice about the management of shock, peritonitis, intestinal obstruction, etc., so that the book covers a wider field than the title suggests.

In a book covering so wide a field it is inevitable that any single reader should find statements and views with which he is not in agreement. Thus, it seems confusing to find a full account of water intoxication in the chapter devoted to sodium metabolism, and no mention of this condition in the section on the therapeutic implications of the metabolic response to injury. However, such individual criticisms in no way detract from the merit of this monograph, which constitutes a valuable addition to British surgical literature. This book is not for those seeking a quick, easy guide to fluid and electrolyte problems, but will prove invaluable to all those seriously concerned to understand the metabolic changes occurring in their patients, and to such students the value of the book is enhanced by a good index and full references.—L. P. Le QUESNE.

HUMAN LIMBS AND THEIR SUBSTITUTES. By Paul E. KLOPSTEG, Ph.D., Sc.D., and Philip D. WILSON, M.D., with thirty other contributors. Prepared under the sponsorship of the Advisory Committee on Artificial Limbs, National Academy of Sciences and National Research Council. $9\frac{1}{4} \times 6\frac{1}{2}$ in. Pp. xiv + 844, with 400 figures. Index. 1954. New York, Toronto, London: McGraw-Hill Book Company Inc. Price 90s.

The subtitle of this book well sums up its contents: "... results of engineering and medical studies of the human extremities and application of the data to the design and fitting of artificial limbs and to the care and training of amputees." Its contributors number thirty-two.

After the war the Americans decided that the limbs available for their veterans were not good enough. And they set about improving them in a fashion reminiscent of the jingoism of 1900: "We've got the ships, we've got the men, and we've got the money too." They had the machines, the brains and the money; and they have made good use of all three. Aircraft and other firms have built prototypes at the instigation of the men of science, the universities have lent their professors, and the American Government, as always for a good cause, did not stint the money. What has been learnt is recorded at length in this book. That the results so far have been meagre does not detract from the magnificence of the effort. It may be some time before a cure is found for cancer but who would wish to call off the search?

A book teeming with engineer's drawings and calculus equations does not commend itself at first sight to a mere doctor, but intermingled with the chapters on mechanical details are many on subjects of interest such as the present status of cineplastic amputations, the physiology of walking and the function of the hand. Nobody will read the whole of the book, but many different people—engineers, limb makers, limb fitters, physiotherapists and physiologists—will find something to interest and stimulate them, not least the orthopaedic surgeon.

The whole world owes a debt of gratitude to the Americans for their efforts to alleviate the lot of the limbless. May their work continue.—George PERKINS.

TREATMENT OF RESPIRATORY EMERGENCIES INCLUDING BULBAR POLIOMYELITIS. By Thomas C. GALLOWAY, M.D., Professor Emeritus of Otolaryngology, Northwestern University Medical School; Attending Otolaryngologist, Evanston Hospital, Evanston, Illinois. 9×6 in. Pp. viii+94, with 5 figures. 1953. Springfield, Illinois: Charles C. Thomas, Publisher. Oxford: Blackwell Scientific Publications. Price 21s. 6d.

In this monograph two introductory chapters on the mechanics and pathological consequences of respiratory obstruction prepare the way for a full account of the respiratory complications associated with acute bulbar poliomyelitis. The author believes that one of the primary disorders that occur in bulbar poliomyelitis is a deficiency in the swallowing mechanism, with consequent accumulation of secretion and food in the air-way. This in turn leads to laryngeal spasm, and it is laryngeal spasm rather than flooding of the lungs by secretions that causes death from asphyxia. Treatment therefore is directed towards removing the secretions by postural drainage and aspiration or, if necessary, maintaining a free air-way by tracheotomy. The indications for tracheotomy are clearly given, and some special points in technique are described. Not everyone will entirely agree with the statement, "It is certainly much better to perform such an easy and safe procedure as tracheotomy many times too early or unnecessarily than to have failed to do it once in time to prevent serious consequences." This book goes a long way to clarify the pathology of acute bulbar poliomyelitis, and to rationalise treatment. It is well produced and the diagrams are clear.—Donal BROOKS.

LOCAL ANALGESIA: HEAD AND NECK. By Sir Robert MACINTOSH, D.M., F.R.C.S. (Edin.), F.F.A.R.C.S., Nuffield Professor of Anaesthetics, University of Oxford; and Mary OSTLERE, M.B., M.R.C.P.E., F.F.A.R.C.S., Research Assistant, Nuffield Department of Anaesthetics, University of Oxford. Illustrated by Marjorie BECK. 9×6 in. Pp. viii+138, with 145 figures. Index. 1955. Edinburgh and London: E. & S. Livingstone Ltd. Price 27s. 6d.

This is an example of all that is best in a medical monograph. It covers its subject fully and clearly, yet succinctly. It is liberally illustrated by diagrams which are always clear and to the point, and the quality of illustration and of presentation is superb. Though most of the book deals with topics outside the field of orthopaedic surgery, it is to this book that the orthopaedic surgeon should turn if he wants the clearest account of simple techniques for stellate ganglion block, cervical plexus block or for local anaesthesia anywhere in the head or neck.—D. Ll. GRIFFITHS.

THE LIFE OF LORD NUFFIELD. A Study in Enterprise and Benevolence. By P. W. S. ANDREWS and Elizabeth BRUNNER. 9×6 in. Pp. xvi+356, with many photographs. Index. 1955. Oxford: Basil Blackwell. Price 25s.

It is extremely difficult to succeed in giving an accurate account of the contributions and main personal features of any living man, but it is even harder to publish a well balanced and objective biography during his life of such a figure as Viscount Nuffield, who, perhaps better than any other contemporary industrialist on this side of the Atlantic, embodies the best that has emerged from the industrial world.

This book will surely be reviewed—and the life of Lord Nuffield that it presents will be commented upon—from angles other than those with particular appeal to an orthopaedic surgeon. It is not the great industrialist or the successful " self-made man " which interests us in this biography, but the part that concerns Lord Nuffield's contributions to medicine in general and orthopaedic surgery in particular. On several occasions he has stated that what has given him the greatest satisfaction were his benefactions for the prevention of crippling diseases, thus making orthopaedic surgery—together with anaesthetics—his particularly cherished field of endeavour. He has even said that his recent gift of £250,000 to the Royal College of Obstetricians and Gynaecologists has been made with the main idea of helping in the prevention of the crippling disabilities that occur during pregnancy and particularly during complicated delivery.

From the book we review we may quote the following main contributions to orthopaedics that have come from Lord Nuffield's purse to which his more recent gift to the Nuffield Orthopaedic Centre is added: £132,380 to the Wingfield-Morris Orthopaedic Hospital before its unification with the Nuffield Orthopaedic Centre; £250,000 to the Nuffield Orthopaedic Centre, Oxford; £450,000 to Oxford University to create the first Chair of Orthopaedic Surgery in the country; £275,000 to the Nuffield Fund for Cripples; £321,000 to the Nuffield Fund for Orthopaedic Services in Australia, New Zealand and the Union of South Africa.

Thinking of the size of the benefactions which this biography reveals—nearly £27,000,000, the greater part of it dedicated to medicine—the suggestion seems unavoidable that on few occasions may so much good have been done by a single man. And here is where the other part of the personal history unfolded in this book is also of interest. These enormous funds were not raised by patrolling the Caribbean seas, as some wealthy men in the eighteenth century did, or by the strenouus exertion of labour force as in Dickens's time, but giving due consideration to the basic rights on which the dignity of the Western man rests. In fact this book itself is the product of a research scheme undertaken by two of the scholars working at Nuffield College, Oxford, the main purpose of which is to encourage the study of what is now known as social science. It is worth noting that the very existence of this college is due to the donation of over £2,000,000 by this unique benefactor.

The greatest tribute one can pay to the writers of this biography is that they have been able to infuse life into the cold, objective collection of materials on which the whole book is built. This biography should be placed in the hands of young people who, judging by the frustration they may experience under the formidable pressure of the State, may conclude that there is no future for the creativeness of the individual man. In this respect the personality of Lord Nuffield acquires the size of a legendary figure capable of inspiring the imagination, as genius usually does, of the younger generation both of to-day and of times still to come.—J. TRUETA.

ATLAS OF PLASTER CAST TECHNIQUES. By E. E. BLECK, M.D., Orthopedic Surgeon, San Mateo Clinic, Calif.; Nellie DUCKWORTH and Nancy HUNTER, Technicians, North Carolina Orthopedic Hospital, Gastonia, N.C. 9½×7 in. Pp. 128, with 347 figures. Index. 1956. Chicago, Illinois: The Year Book Publishers Inc. London: Interscience Publishers Ltd. Price 36s.

This is not a work on casting but on casing; why do otherwise discerning folk miscall a case a cast? The safe and skilful use of plaster can be learnt only by practice, but this is not to deny a place for written precept, especially when so profusely illustrated as in this book. The authors have avoided the pitfall of some predecessors who devote much space to putting plaster on and almost none to taking it off. The book is written for a dangerous part of the community, " the novice in plaster techniques and the occasional user of plaster immobilisation." Nearly the most dangerous advice

to give to such people, or indeed to anyone, is to put bits of felt over bony prominences; yet this bad practice is enjoined and illustrated throughout the book; even the calcaneum is not exempt. Nevertheless there is much useful instruction here for the beginner; in the words of Leonardo da Vinci, "Let him make himself a Master of the Theory, before he meddle with the Practice."—H. Jackson BURROWS.

AN INTRODUCTION TO POOL EXERCISES. By Elizabeth BOLTON, M.C.S.P., H.T., Diploma of Bedford Physical Training College; and Diana GOODWIN, M.C.S.P., H.T. Foreword by J. W. T. Patterson, M.D., F.R.C.P.Ed. $8\frac{1}{2} \times 5\frac{1}{2}$ in. Pp. 48, with 39 figures. 1956. Edinburgh and London: E. & S. Livingstone Ltd. Price 5s.

Everyone is agreed that there is no substitute for pool therapy, particularly for patients with poliomyelitis. Warm water has a soothing effect and its buoyancy enables the severely paralysed

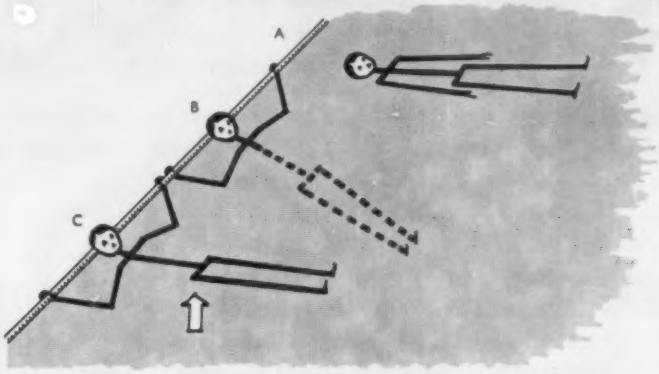

FIG. 1

Diagrammatic example of when support is necessary.

A. Body floating free but control of localised movement difficult.
B. Head and shoulders fixed preparatory to controlled leg movement, but body sinks as more than 0·026 of the body is out of the water.
C. As previous position but pelvis supported. Controlled movement now possible.

patient to carry out movements that are impossible on dry land. This little booklet, which is well illustrated by clear diagrams, describes exercises that are particularly suitable for use in water. It will prove useful for those physiotherapists who have not had particular experience in pool therapy, and will be stimulating to others already familiar with this form of treatment.—Donal BROOKS.

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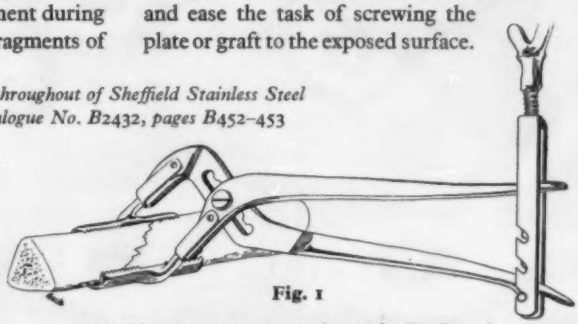

Fig. 1

Swivel jaws ensure pressure is evenly distributed, and fragments which taper or are of different diameters are securely held.

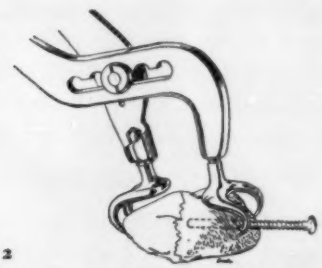

Fig. 2
Hooked jaws used to grip a fractured patella.

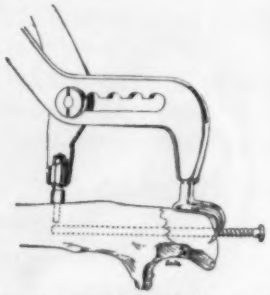

Fig. 3
Hooked jaw and peg used to grip fractured olecranon (also medial malleolus). ⅛″ diam. hole drilled in shaft of ulna or tibia acts as fixation point.

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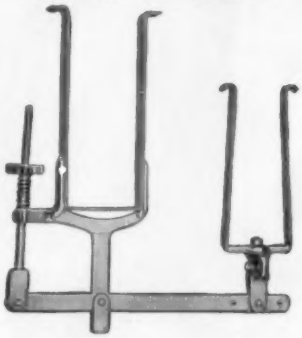

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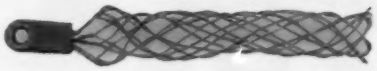

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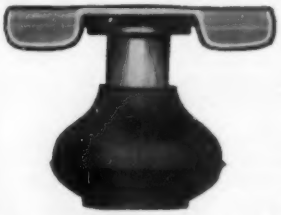

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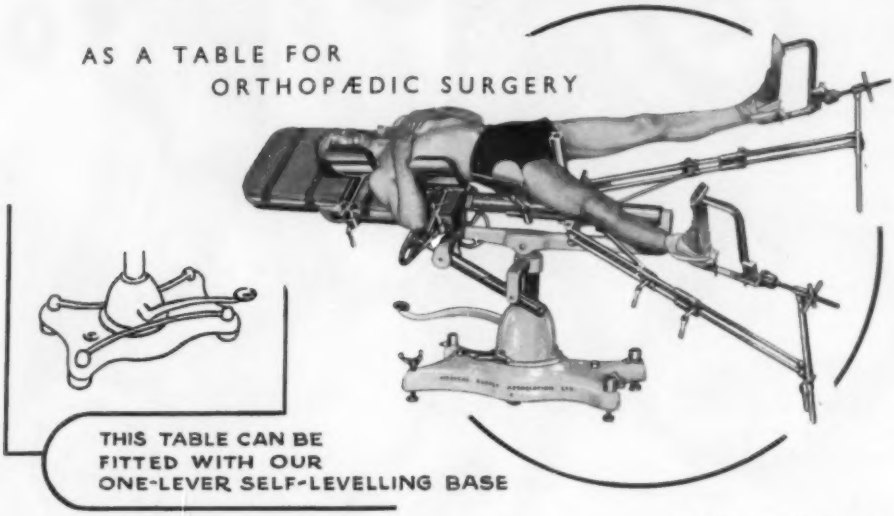

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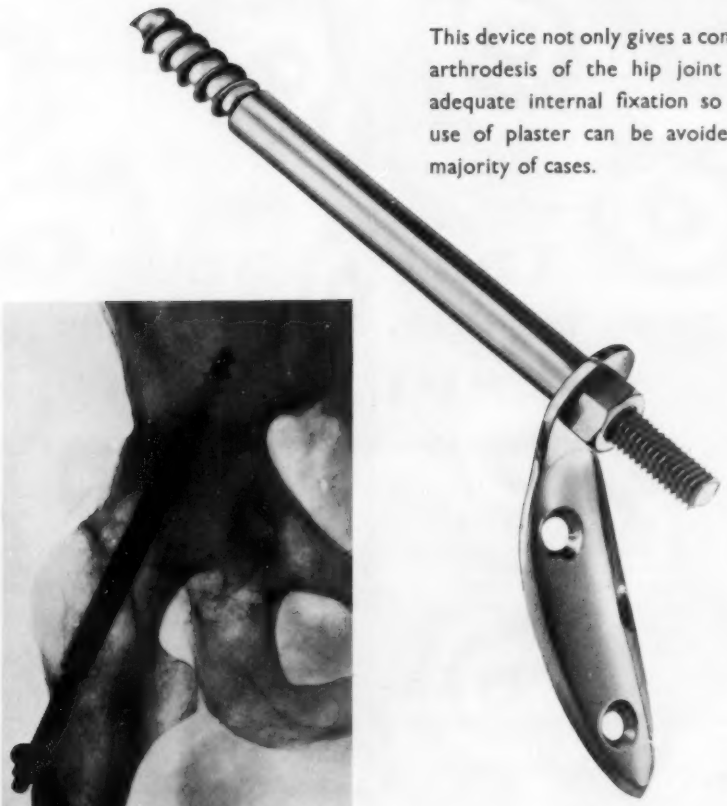

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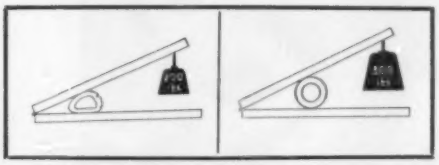

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* (1) *J. of Bone and Joint Surg.*, 1955, **37B**, 639.
(2) *ibid.*, 1955, **37B**, 640.

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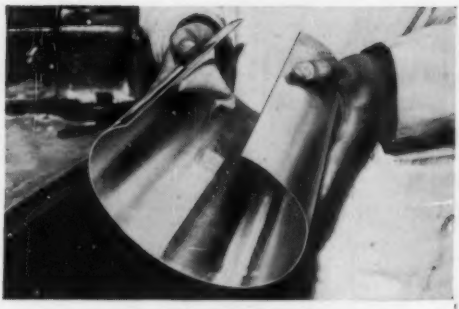

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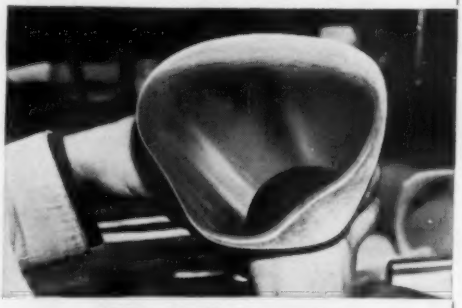

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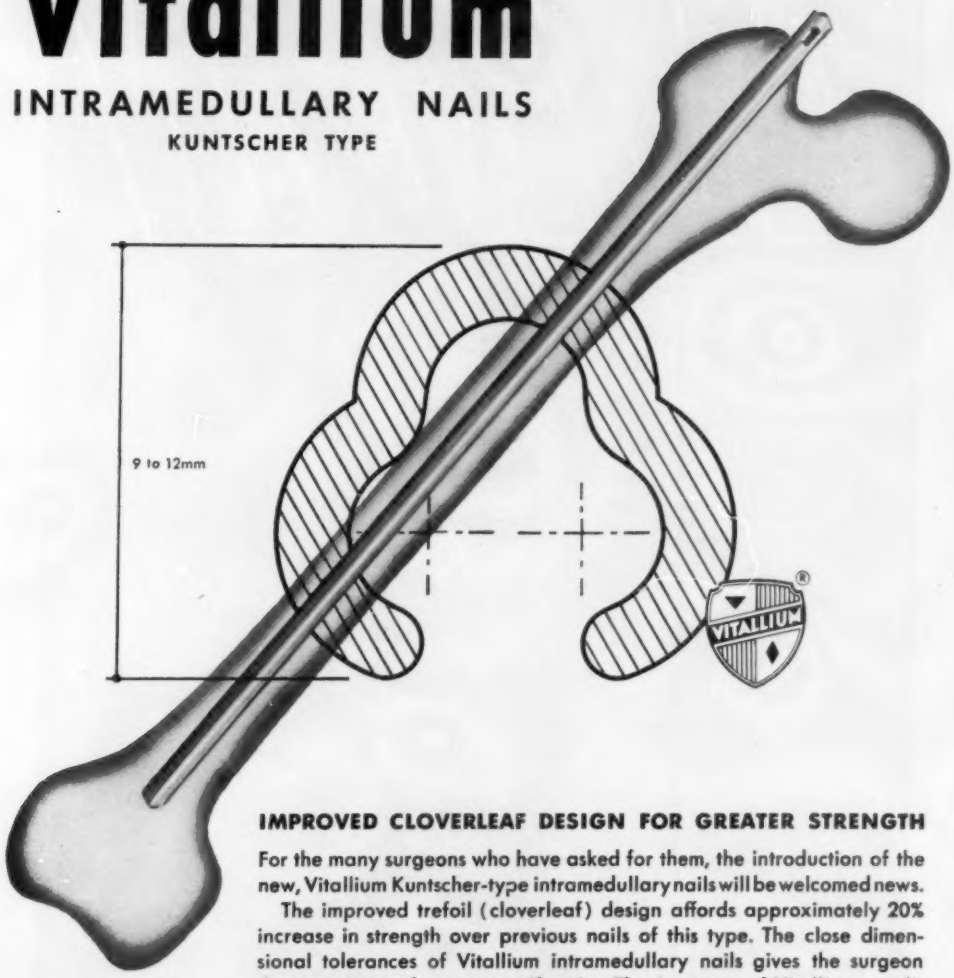

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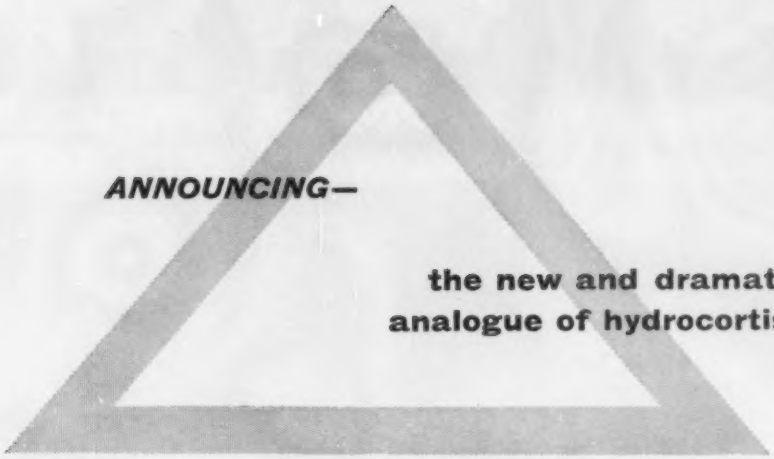

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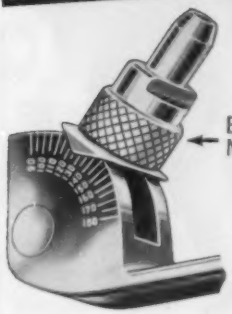

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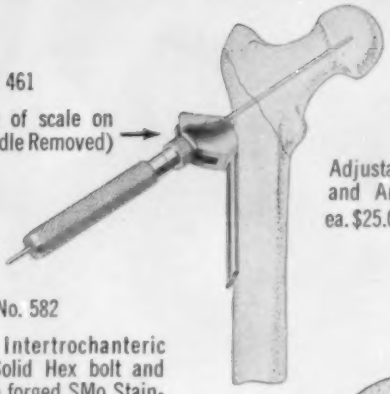

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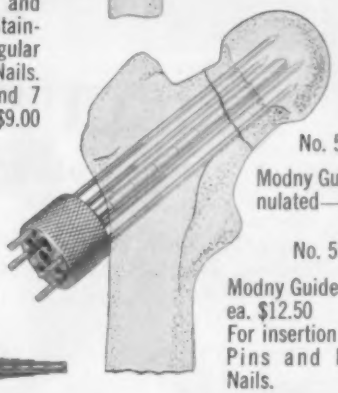

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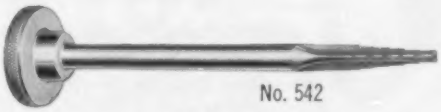

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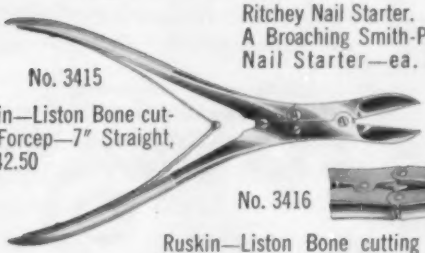

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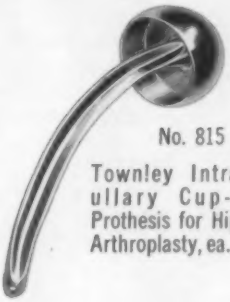

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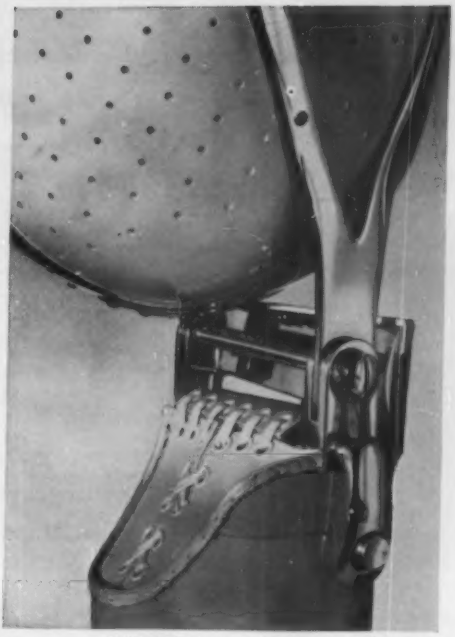

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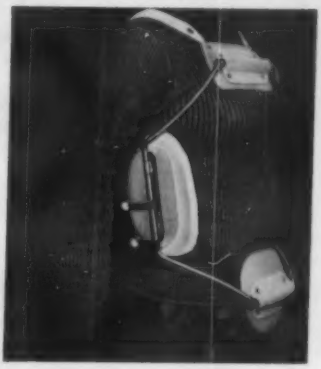

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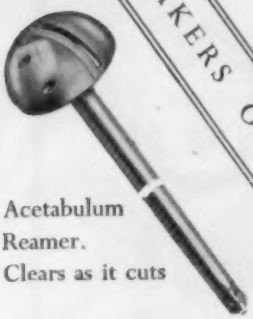

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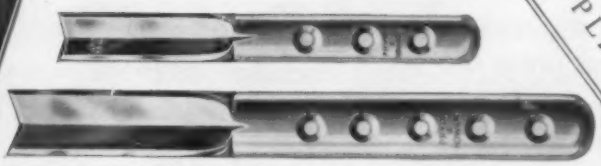

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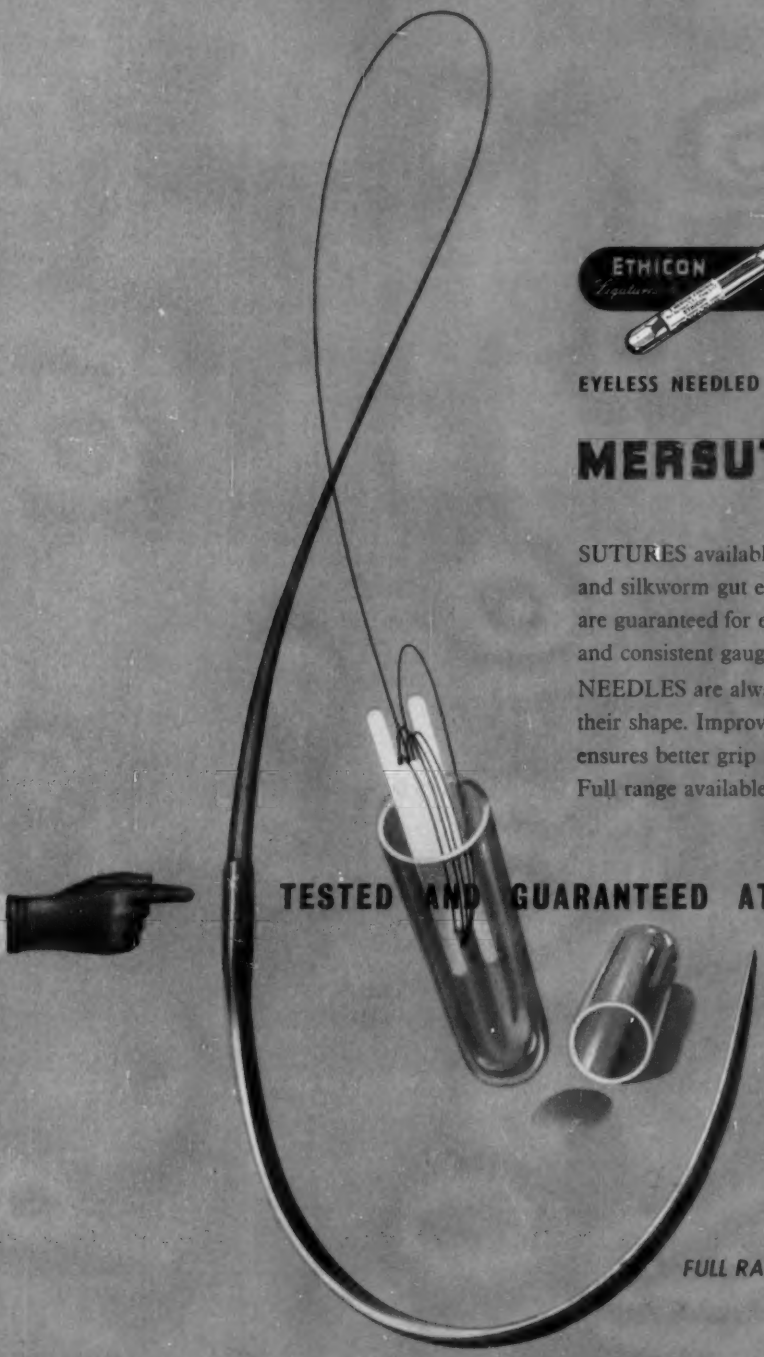

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